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Maintenance of

BITUMINOUS SURFACES AND SHOULDERS

In Connecticut

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Photographs and Drawings by Courtesy of the Connecticut State Highway Department

Treated Shoulders at Side of Concrete Pavement in the Town of Salisbury. This was the typical shoulder treatment here described.

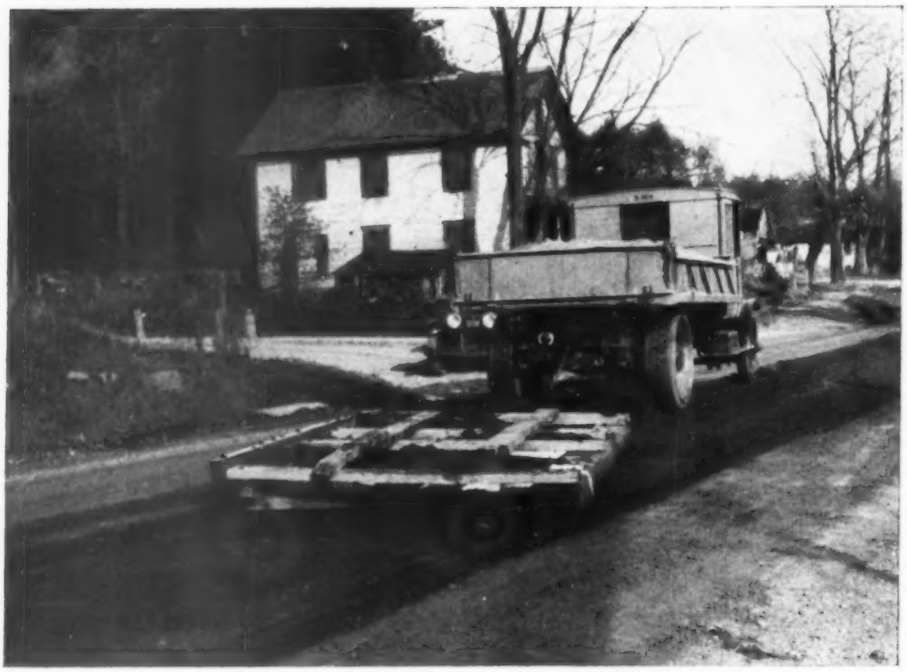
THE Connecticut State Highway Department's system of bituminous treatment for shoulders of native material, and for the entire surface of various macadam and other types of road, has brought a steady reduction in maintenance costs and a betterment in road quality during the 15 years through which it has been developed.

In essence, in its present form, the system involves a very light bituminous treatment twice a year, followed as quickly as possible by thorough honing. The procedure necessarily varies somewhat with conditions, and may be applied either more or less often than the average.

Ordinarily the surface-treating season extends from March to October, but is prolonged when neither snow nor excess water conditions interfere. The roads are thus maintained in a consistently good condition at all times with little or no rush of spring repairs. One effect of this method is to cut the labor turnover, the department pointing with pride to the superior character of its employes and its annual turnover rate of less than 10 per cent. Between 100 and 115 maintenance crews are employed, each of which as a part of its regular work, cares for the bituminous surfaces in its own district.

Materials

The bitumen used on maintenance is an 8 to 13 viscosity tar. This may appear exceedingly light, but it must be remembered that in combining with and reliveningthe old surface material a higher viscosity (probably



An Ordinary Honing Operation in Which High Spots Are Cut and Low Spots Filled.

around 25) is quickly developed. Heavier tars used on earlier work were gradually displaced by lighter grades until the present standard was reached. On previously untreated surfaces, such as new waterbound macadam, a 13 to 18 viscosity tar is generally used for the first application, but subsequent maintenance is all with the lighter grade. On first treatment of shoulders a priming application of 45% asphaltic oil is used, followed by a sealing coat of 8 to 13 viscosity tar. The quantity of asphaltic oil for this purpose ranges from ½ gal. to ¾ gal. per square yard. Material in shoulders varies from the best sandy gravel to admixtures of sand, hardpan and loam.

The retreatment application rate in most cases is from 1/10 to ⅛ gal. per square yard, though either more or less may be used on occasion. Application temperature is about 120°F. The foremen acquire great skill in judging the amount of bitumen required and in applying it uniformly at the proper rate. A special extending and folding distributor pipe is used on shoulders, the design permitting close limitation of the bitumen to the area to be covered and preventing damage to guard rails, fences, and other structures. Sand is spread at the rate of about 4 lbs. per square yard immediately after the bitumen. Hand spreading is preferred, as giving the most uniform results, and is used on most of the work. Machine spreading, however, is used to a limited extent.

Honing

The hone is applied as soon after the application of bitumen and sand as possible, although a delay of a few hours, or even a day or two, is not considered serious. Where crown is high, honing is conducted from the center of the road to the sides; while with low crowns it is done from side to center. In an ordinary maintenance operation the hone is drawn over the surface from one to six times, according to the amount of cutting, smoothing, and distributing required. In special cases, such as extremely hard old surfaces, the amount of necessary honing may be increased. The maintenance crew's general purpose truck (usually of 3½ tons' capacity) pulls the hone in most cases. A special hone is provided for use on narrow shoulders. All of these hones are made by the department.

The honing process comes near to being the vital feature of the treatment, and is done with the greatest care. It not only cuts humps and fills hollows, but is depended

Mystic—Old Mystic Road in the Town of Stonington. On the right-hand side of this road, indicated by a slight change in surface color, is the location of an old trolley track which was removed. The area was filled with gravel, surface-treated with tar, and honed, thus providing approximately 25 ft. of good roadway against the 16 ft. existing previous to the removal of the track.

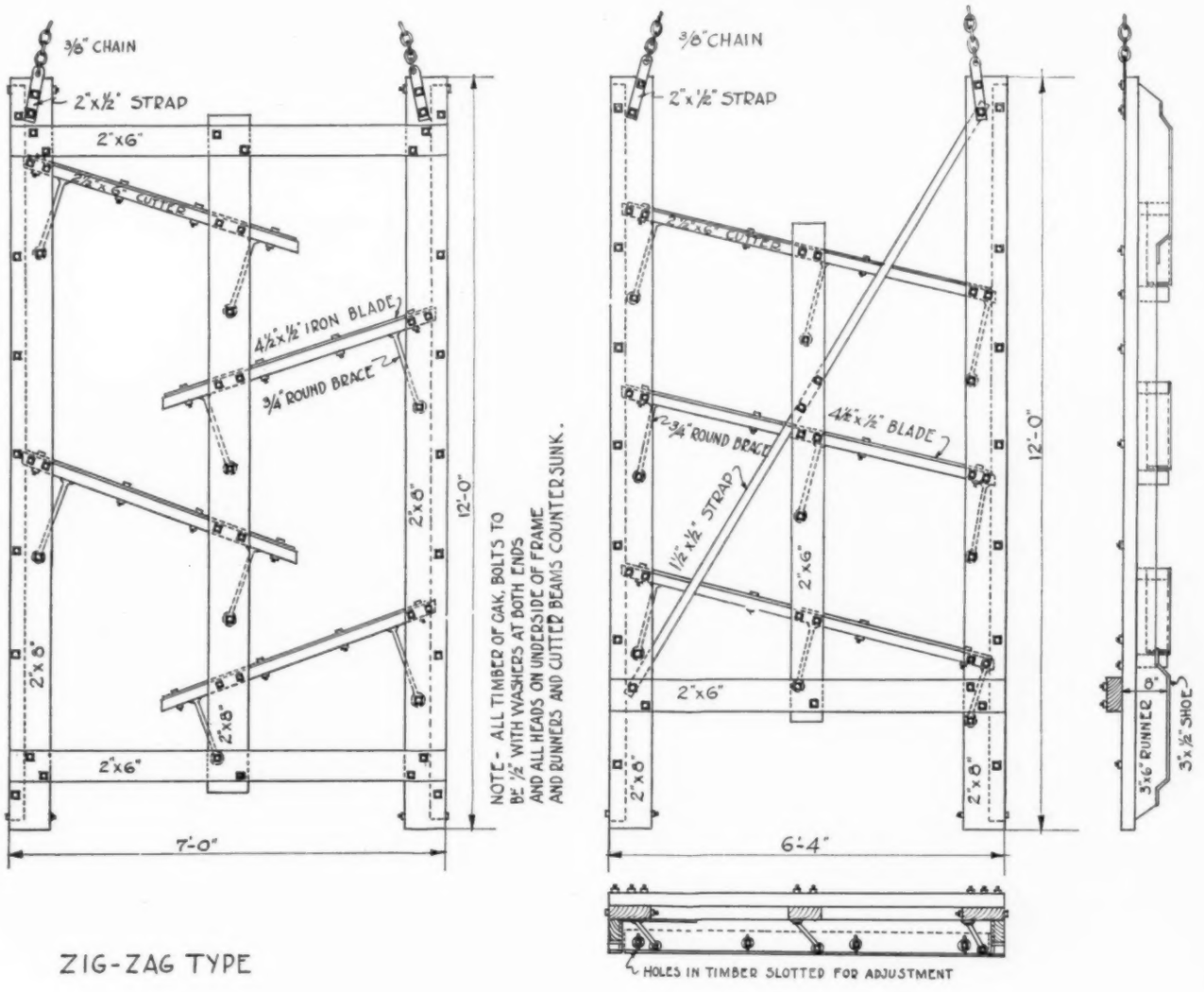
on to keep the tar coat down to the minimum practical thickness. As a result there is no surface shoving, and the roads, as far as the writer could observe, were entirely free from waves. The normal thickness of treatment above a macadam or gravel surface ranges from 1/16 in. to ⅛ in. and is practically independent of the age of the road or the number of treatments it has received. Penetration into the roadbed averages about 3 in. on either the main traveled way or the shoulders. When excess material accumulates it is simply honed to the side and removed.

Shoulder Treatment

Old waterbound macadams (usually with some previous surface treatment) are frequently widened with gravel shoulders treated in the manner here described, following a priming coat of from ½ to ¾ gal. of light asphaltic oil which has been allowed to penetrate the shoulder and has been thoroughly incorporated and consolidated by honing. Succeeding treatments are applied to the entire surface—both center and shoulders—and the whole finally acquires a uniform appearance, with no distinguishing line between the two types. In other instances only a very faint division is seen. Similarly, treated gravel shoulders at the sides of bituminous macadam or asphalt pavements bear a very close resemblance to the center strip. Shoulders adjoining concrete, though standing out clearly because of their color and texture, leave no gap for the entrance of water. The two surfaces appear tightly bound, the one to the other. Occasionally in the Spring a narrow crack will develop at the joint between shoulder and center, or in the shoulder near the joint. Such cracks seldom require any special attention, but are left until the maintenance crew reaches them in its regular routine of surface treating and honing.

Improved Conditions

With adequate side and subsurface drainage, a tight roof maintains a dry cellar, and the effectiveness of the bituminous treatment to this end is evidenced by the present infrequency of frost boils which once were a major source of trouble. Where boils do occur, or where there are breaks from other causes, repairs are made with a tar and sand mixture the same as that composing the rest of the surface. This insures uniform



ZIG-ZAG TYPE

REGULAR TYPE

Types of Road Hones in Use by Connecticut State Highway Department

hardness of the patch and its surroundings and minimizes either raises or depressions. Where oiling is done in the fall, the boils are almost entirely eliminated.

Before shoulder treating in Connecticut, there was much scouring and washing under heavy rains. This required the grading back of washed-down material (in some instances the filling-in of new material) and was a source of both nuisance and expense. Furthermore, soft or rutted shoulders induced accidents. Regular treatment brought a marked reduction in the cost per mile of shoulder maintenance—costs decreasing steadily as methods were developed and improved.

The floods of last March tested the treated shoulders severely in many places, but in only minor locations were they reported as having broken through. Undercutting from the side damaged or destroyed them at certain points, but so it did also with heavier and more expensive surfaces. The treated shoulders undoubtedly saved a large amount of costly erosion.

Costs

An ordinary bituminous retreatment costs between 2½ and 3 cents per square yard at the present scale of prices. This includes all items of labor and material —bitumen, sanding, honing, etc. Special conditions may produce costs per yard considerably above or below normal.

Common labor is paid 50c per hour. Tar costs about 8c per gallon F.O.B. refinery or distribution point. In some localities sand is purchased at $2.00 per cubic yard at the storage bin, but in general it is obtained from state-owned deposits, and costs approximately $1.00 per yard spread upon the road.

In an ordinary day's work, a maintenance crew will apply 10,000 gal. of oil, which means from 80,000 to 100,000 sq. yd. treated, including the sanding and honing necessary for a completed surface. However, under exceptionally favorable conditions, as much as 22,000 gal. has been applied in a day with a single 1,000 gal. distributor.

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Flood Damages to Roads and Bridges

Special funds now available for repairing flood damage to roads and bridges on the Federal-aid system are estimated to be sufficient to pay half the cost of restoring with modern structures most of the bridges on the system destroyed in the recent extraordinary floods. Thomas H. MacDonald, Chief of the Bureau of Public Roads, made this estimate at a recent transportation conference at the U. S. Chamber of Commerce. These special funds amount to more than $7,000,000 of the $10,000,000 authorized by the Hayden-Cartwright Act of 1934. Federal participation is limited to half the cost.

Mr. MacDonald said, "When such floods occur, almost without exception it is the old-time structures that are seriously damaged or totally destroyed. This does not mean that the loss of the facility to the community is not serious or the replacement costly, but that modern design is producing bridges that do withstand extraordinary floods. This is true, in a broad way, of modern high type road construction."

The chief of the Federal roads bureau said that the flood damage, although spectacular, caused much less loss than did the deterioration over many miles of pavement and wide areas caused by the severe winter.

Principles Proposed for New York State Highway Program

In order sensibly to prepare legislation for highway improvement the Highway Committee of the New York State Legislature made the following recommendations to the Legislature:

State System.—1. Complete the construction of the State system of highways as now shown on the official map on an eight-year program.

2. Reconstruct, resurface or widen about 5,300 miles of highways on the State system, including bridges, on a five-year program.

3. Rights of way necessary in the construction or reconstruction of highways on the State system to be acquired by and at the expense of the State.

4. The State to assume general supervision of snow removal and sanding on the State system, the work to be performed under agreements with the counties.

County System.—1. Complete the construction of the county road system as now shown on official maps.

2. Provide additional State aid toward the reconstruction of a portion of the county system.

3. Continuance of present State aid to counties in accordance with existing law.

Town System.—1. Complete the construction of the town highway system in accordance with the plan proposed by the committee and provide additional State aid toward the cost of such completion.

2. Continuance of present State aid to towns in accordance with existing law.

Cities.—1. Construct at State expense a system of arterial and by-pass highways in and through up-State cities on a five-year program.

2. Provide State aid to up-State cities for general highway and street maintenance purposes.

3. Provide additional State aid to New York City for arterial and by-pass highway construction.

General.—1. Relieve the State, counties and towns of liability for damages on highways caused by snow and ice.

2. Construction of sidewalks as a part of the cost of highways.

3. Installation of highway illumination on a limited mileage on the State system to determine desirability, effectiveness and cost.

4. Removal of all advertising signs adjacent to public highways which constitute a hazard to traffic.

5. Further study of the classification of highways with a view of limiting the loads which may be transported over the various systems.

6. Provide for extending the parkway system outside of cities.

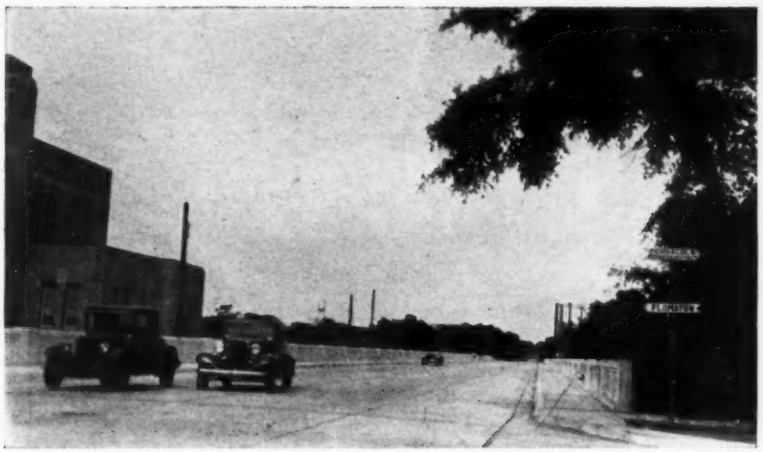
7. A more uniform method of marking by directional signs to promote traffic on less frequented highways and to more clearly designate routes to be followed in passing through cities.

8. Continuance of refund to counties and New York City of fuel tax and registration fees on the basis of present laws.

9. A permanent three-cent fuel tax and continuance of present registration fees, the receipts to be used only for highway purposes.

10. Adoption of the average annual highway program recommended by the committee to be financed from a three-cent fuel tax and present registration fees, the major items not to become effective until 1937, and thus not affect the present budget appropriations.

A GRADE CROSSING ELIMINATION IN FLORIDA



Looking East from Palafax St. at West End of Viaduct.

TIMBER, STEEL AND CONCRETE COMBINED IN ECONOMICAL DESIGN

THE 972½ foot viaduct completed early in 1935 on Cervantes St. in Pensacola, Florida, has a 52 ft. 4 in. concrete deck on I beam stringers supported on 35 creosoted pile bents. Abutments and approach retaining walls are of reinforced concrete founded on concrete piles. The structure was built by the State Road Department of Florida as a Federal Aid project using National Recovery funds, and was designated Project N. R. M. 109-B. The entire project is 1230.37 ft. long. The contract price was $103,814.84, or $84.40 per linear ft. The price per square foot over all area was $1.61

Profile and Other Considerations

The principal purpose of the viaduct is to carry U. S. Route 90—known as the Old Spanish Trail, and here located on Cervantes St.—over three tracks of the L. & N. R. R. This crossing is located at the eastern side of a small valley, and it was considered better to carry the elevated highway clear across the depression than to drop back to ground level only to begin the climb of the western slope immediately.

The easterly end of the project is at Sta. 76+44.58, where the ground is about 3 ft. below grade. The roadway is carried on a fill between retaining walls to the abutment at 77+80.40, where there is a height of 11 ft. from ground to grade. The center of the railroad crossing is reached near Sta. 80+50, grade being approximately 27 ft. above rail tops. Maximum height of structure is 33 ft., which occurs near Sta. 83+80. Gillimard St., the only other crossing on the project, is located at this point.

From Sta. 84+60 the ground rises rapidly to the end of the project at Sta. 88+74.95, where the fill is approximately one foot. The westerly abutment is located at 87+52.94. A fill between retaining walls carries the road from the abutment to the end of the project. Bridge and approaches are on a single tangent. There is a plus grade for the entire length, the maximum being 4.913% between the beginning of the project and the railroad crossing. From the latter point the rate is 0.40 per cent to the westerly end. The grade changes are made by easy vertical curves.

The 43 ft. Span Over Gillimard St.

The owners of residences and certain other abutting properties protested the improvement, but were overruled because there appeared to be no other solution for the serious crossing problem.

Substructure

Double bents, each with two rows of batter piles, support the long spans at the railroad and the crossing over Gillimard St. The remaining 31 bents have a single row of 10 piles each. Pile spacings are 5 ft. 6 in. on centers for all inside piles, and 5 ft. 0 in. between each outside pile and the one nearest it in each bent.

All piles are driven for a bearing of 18 tons or more. Caps are 12 in. by 12 in., spliced with a beveled, bolted joint over the fourth pile from the end in each bent.

View Showing General Features of Substructure—Double Bent at Railroad Crossing in Foreground.

Single 3 in. by 10 in. sway bracing is used where the top of the cap is not more than 20 ft. above ground—double sway bracing where the height is greater. Timber was treated by the full cell process, 20 pounds of creosote per cu. ft. being used on piles and 16 pounds on structural timber.

The tops of piles and tops and ends of caps are covered with 26 gauge galvanized iron, folded down and around corners and secured by stitch-nailing.

The double bents are covered at the top with longitudinal caps of 12 in. by 16 in. timber. 5 ft. 6 in. long, laid flatwise on the main caps of the bents. These longitudinal caps and all blocks which are necessary to adjust I beams to their proper heights are creosoted and covered with galvanized iron in the same manner as the main caps.

An interesting feature of the Gillimard St. bents is that they straddle the sidewalks, thereby shortening the span and reducing its cost. It was feared by some that the clothing of pedestrians might be injured by the preservative, but no trouble has arisen from this cause.

I-Beam Construction

There are 36 spans, 34 of which range from 25 ft. 5¼ in. to 26 ft. 0 in., the majority being 25 ft. 8 in. The span over L. & N. R. R. tracks is 55 ft. 0 in., and the one over Gillimard St. 43 ft. 0 in. There are 10 I-beam stringers for each span, the spacings being the same as the pile spacings. Roadway beams for the 34 short spans are 22 in. deep and weigh 62 lb. per foot. Sidewalk beams ars 16 in. 37 lb.

The 55 ft. span has 33 in. 141 lb. roadway beams and 28 in. 97 lb. sidewalk beams. Beams of the 43 ft. span are 30 in. 108 lb. for roadway and 24 in. 70 lb. for sidewalk. Beams of the shorter spans rest on ¾ in. steel bearing plates—those of the longer spans on 1 in. plates Special plates, bevelled for grade, are provided where needed. All beams are anchored by ¾ in. by 10 in. lag screws through the flanges at each end, one end being fixed and the other end provided with slotted holes to permit expansion.

Concrete Deck

A cross section of the structure shows a 40 ft. roadway with a parabolic crown of 3¾ in., two 5 ft. sidewalks, and railing ledges each 1 ft. 2 in. wide. Pavement and sidewalk are of reinforced concrete, the pavement slab being 8 in. thick and the sidewalks 6 in. There are transverse concrete webs between the stringers of each bent. The slab is designed for an A. A. S. H. O. loading of two 15 ton typical trucks with 30 per cent impact.

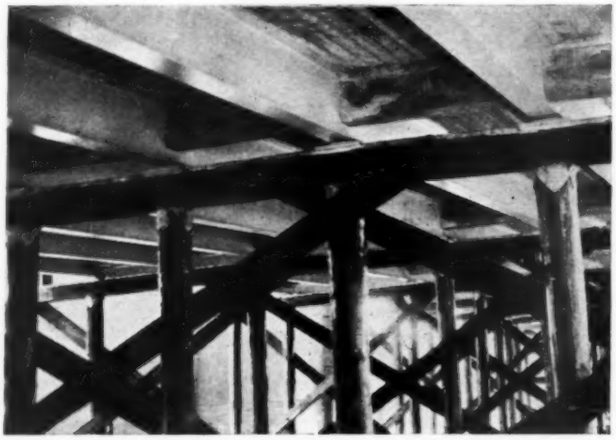
Handrails are of concrete, of pleasing design, with an expansion joint over each bent.

Conclusion

Contract unit prices were as follows:

Concrete in superstructure, abutments, and retaining walls, per cu. yd.	$ 19.65
Concrete hand rail, per lin. ft.	2.40
Reinforcing steel, per lb.	0.0352
Structural steel, per lb.	0.0352
Treated structural timber, per M fbm.	115.00
Treated timber piling, per lin. ft.	1.05
12 in. precast concrete foundation piling, per lin. ft.	3.00

Design and construction were carried out under the direction of J. H. Dowling, State Highway Engineer, and W. I. Nolan, Bridge Engineer. C. J. Kershaw Contracting Co. of Birmingham, Ala., was the contractor.



View from the Under Side Showing Metal Coverings of Piles and Caps, Transverse Webs Between I Beams, and Other Details.

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Modern Highways in China

The construction of modern highways in China is proceeding rapidly and successfully. Considerable improvements in the method of constructing motor highways have been introduced during the past two years. The Central Government co-operates with the Provincial governments and pushes forward the work to meet the conditions of each region. The history of highways in China is comparatively brief. In 1913, Tan Yen-kai, ex-Military Governor of Hunan, built a road from Changeha to Siangtan, both in that province, for military purposes. In 1917, a road from Kalgan to Urga was constructed, to transport commercial products to Mongolia. Because of the importance of highways in all manner of projects of a political, business, social development and military character, the Central Government has laid plans to build modern roads connecting the provinces, with the principal object of transporting troops to bandit areas and commercial products to interior regions where other means of communication are lacking.

SOME UNUSUAL ENGINEERING EXPERIENCES

By HALBERT P. GILLETTE

When Chief Engineer Johnson decided that his employer's best interests required the departure of Mr. Murphy from the neighborhood, that worthy backed his undoubted legal rights with guns, but Johnson's unconventional persuader worked sans bloodshed.

AN IMPORTANT extension of a western railway was under construction prior to the days of prohibition and bootlegging, when saloons went to the men if the men could not go to saloons. Tent-saloons followed the railway construction camps, and the saloonkeepers waxed wealthy. Stephen Johnson, chief engineer of the D. T. Railroad, had no objection to the wealth that Murphy, the saloon proprietor, was amassing, but he did object to the time his workmen spent in carousal after payday, plus the time spent in recovering from alcoholic debauches. The legal department of the D. T. had informed him that there was no way of getting rid of the tent-saloon so long as it was located on land not belonging to the railroad. The government had donated to the railroad every other section of land along the right of way as an inducement to build this extension, but Murphy was careful to squat on a vacant section that belonged to Uncle Sam.

Even aided by this land grant, the D. T. Railroad was unable to pay its bond interest and went into bankruptcy, following the precedent of many similar railway ventures. But this is no part of the story.

Having no legal way of ridding himself of Murphy and his tent-saloon, Stephen Johnson applied his engineering skill to the problem. You shall be the judge of the science that he used in solving it.

Johnson rode over to the Murphy saloon by moonlight and engaged in a diplomatic conversation whose tenor was this:

"Good evening, Mr. Murphy."

"Top of the moonlight to ye, Mr. Johnson. What will ye have to drink?"

"Nothing, thank you."

"It's on the house, Mr. Johnson."

"Thanks, but I can't be friends with you. I have come over to tell you that you have got to quit selling liquor to my men. I have urged you to get out before. This time I tell you to get out before seven tomorrow night."

"You're telling me, eh? Now hark what I'm telling ye. I've got me license from the state; I'm on public land, and I defy ye to put me off."

"Murphy, I don't want any bloodshed, but if you and your liquor are not gone by tomorrow night at seven, there's going to be trouble that may have blood mixed with it."

With this verbal shot Johnson left. Murphy, being Irish, was no coward. Being Irish and aroused, he was not silent. Being not silent, his own fusillade of words had aroused his anger to the roaring pitch. It's the same way with lions.

Half an hour before 7 p. m. of the next day a large crowd had gathered in and around Murphy's tent-saloon. Murphy had doubled the number of his bar-keeps by hiring three more, and each of the six wore a cartridge belt and a brace of shooting-irons. Rifles and shotguns loaded with "buck" lay on a shelf beneath the bar. It was rumored that among the crowd of his patrons, not a few were gunmen hired merely to stand by and see fair play.

This was two generations before the day of the radio crooner, but the spiritual grandfather of that modern variety of songbird was pounding a piano accompaniment to a tune that he sang in an intermittently falsetto tenor. I will say this for the tune, it wasn't stolen. It had just run away from home—a German home—50 years before. The words, however, were indigenous and would add an atmosphere to the story that I must ask you to imagine.

The tenor was rendering the third nocturne in B flat when someone outside the tent shouted in C sharp:

"Here comes Johnson!"

The piano and crooner were drowned by the loud noise of boots on the rough boards that formed the floor of the itinerant saloon. All rushed out to see Johnson and his army. Not a few were even more eager to get out of the no-man's land that lay between Johnson and Murphy.

Could it be Johnson? He was too far away to be recognized in the gloaming, yet the huge size indicated that it was Johnson. Where was his army? It had been reliably reported that he had equipped not fewer than fifty of his engineers and workmen with rifles, and that with their aid he would carry out his threat of the previous day.

Everyone knew Johnson to be a man of few words, each one of which he meant. The long scar on his cheek was put there by a drunken Indian. Witnesses of the origin of that cicatrix had said that the Indian had not touched a drop of liquor since.

I have often read of the defying shouts of men about to do battle. My observation has been that upon such occasions there is no shouting. On the contrary, language takes on a muffled tone. So it was in this case. It was five minutes after Johnson came into view before he reached the crowd, which had opened up, forming a wide—a very wide—lane. Yet during those five minutes there were only subdued remarks, and few of them. Not until Johnson had dismounted and had thrown the reins over his horse's head did any one speak loud enough to be heard by all. Then it was Murphy's voice saying:

"The end of the day to ye, Mr. Johnson."

"Good evening, Mr. Murphy."

"Well, ye see I'm still here, Mr. Johnson—me and me bar-keeps and me tent and me piany and me whiskey and a few of me guns."

"I see all that, except the piano and the whiskey, and I'll take your word for them. But let me remind you that it is not yet seven, by exactly two minutes."

At that many eyes began to scan the willows back of the saloon. Had Johnson ambushed them? He himself was apparently unarmed. At least he carried no rifle, nor was a pistol to be seen on him. He took out a heavy

silver watch, opened its lid, gave its face a glance, put it back, flicked the ashes off his cigar, walked over to his horse, and began unstrapping a saddle bag. Having removed the bag, he walked toward Murphy.

"Mr. Murphy, it's my unpleasant duty to serve on you some papers of eviction."

"Papers of eviction, is it? Well, you can serve 'em and be damned. I've got lawyers, too, Mr. Johnson."

"Well, these are papers that your lawyers will find very difficult to answer, Mr. Murphy."

The two men were now almost within striking distance of one another, Murphy standing just in front of the tent, with some twenty armed men behind him. The tension having greatly relaxed when Johnson spoke of serving eviction papers, the crowd began moving toward Johnson and Murphy.

"Stand back!" shouted Johnson. The men froze where they were. Johnson took his cigar out of his mouth and brought its lighted end into contact with something that looked like a thick cord that stuck out of the bag.

"It's a fuse!" cried someone.

"Right you are, and a damned short fuse," replied Johnson as he flung the saddle bag loaded with dynamite through the door of the tent.

"Run like hell, men. It will explode in ten seconds," he shouted.

Suiting his action to his own advice, Johnson dashed for his horse. Sprinting records were made by dozens of men simultaneously. If the records did not fall at once, they certainly did when the remnants of the bar, the "piany" and the saloon itself began to fall. There was a hail of such fragments and a cloud-burst of whiskey following the thunder of the explosion.

Should this account chance to be read by any of the many winners of that unanimous sprint, I shall be glad to receive any further details that have escaped my memory. I shall be especially glad to hear from Mr. Murphy, for he, I have been told, hung up a record that I hesitate to quote until I receive his personal confirmation of it.

* * * *

The Story of the Extra Coffin, or How Foreman Hop Too Solved a Problem in Management.

THE solution of one problem of engineering always suggests another. So I pass to a second one that antedates the first in point of time, and is likewise an actual episode. I got it from a division engineer who had been so hard put in his attempt to finish his construction division on time that he enlisted the assistance of a Chinese foreman.

Van Don, division engineer of the C. O. D. Railroad, could find in engineering text-books no solution of his troublesome problem, nor was his own ingenuity able to devise a solution. The ancient Chinese were original, he had read. Possibly his Chinese foreman, Hop Too, might be a descendant of one of the Chinamen to whom we owe the magnetic compass, gunpowder and the wheelbarrow. So he sent for Hop Too. But I am getting ahead of the story.

It was October 10th, and Van Don's problem was to complete the grading through a difficult section of the mountains before November 15th. His earth grading gangs were Chinese coolies imported from China. This was in the 80's, when American common laborers were scarce on the Pacific slope. With picks, shovels, wheelbarrows, and Chinks at a dollar a day, dirt could be dug and moved several hundred feet at 15 cents a cubic yard. We beat that now with power shovels and Americans whose "real wages" are five-fold those of those Chinese coolies in America in the 80's and fifty-fold what those coolies could then earn in China.

Van Don had just reported to the chief engineer that the grading on his division would be completely finished by November 15th, when a roaring wind swept over the construction camp, toppling over giant firs and piling them up like jackstraws. Under those jackstraws were Chinamen whose silence indicated that they had suddenly become eligible for ancestor worship, and others whose moans gave speed to the rescuers. Under Van Don's direction, many crosscut saws were manned by Chinamen; pevees were soon rolling logs away, and stretchers were carrying the wounded to an improvised hospital; the dead to an improvised morgue. Poor devils all. Six thousand miles from home, in a land none too hospitable; saving nearly all of the daily dollar, they had worked hard by day, and at night had dreamed of going home. Twelve would dream thus no more; they were going home in boxes.

"Order twelve coffins from Seattle," said Von Don, when the last missing Chinaman had been found beneath the jackstraw trees.

The next morning the caskets arrived on a flat car, not twelve but thirteen; the extra one sent by mistake or for good measure. When the assembled Chinamen found that there were thirteen coffins, a murmur started, which became violently loud. Van Don was puzzled.

"What's the matter, Hop? Are your men superstitious about the number thirteen?"

"No, Mista Van. One coffin no got dead man. All live man flaid he dead tonight and fill empty coffin."

"Nonsense, Hop. Tell them what I say."

With several gutterals that ended in a high falsetto, Hop said in Chinese:

"The big boss says nonsense."

You may interpret this sentence two ways, depending upon whether you pause or not after "says." The Chinese interpreted it with no pause after "says." Silence visited their lips, nor did that grim visitor depart that day, that night, the next day, or the next night. They lay in their beds or sat smoking on logs, silent. Van Don attributed their silence and refusal to work as being more a sort of mourning than superstitious fear, but when he could get from Hop Too no assurance as to when his men would return to work, he became exasperated.

On the morning of the third day, seeing no evidence that work would be resumed by the Chinamen, he said:

"See here, Hop, these holidays must end today. If not, I will send to Seattle for new men."

"Velly solly, Mista Van, but not many China boy in Seattle."

Van Don knew this to be the case, but he had hoped that his threat would bring the Chinese in the camp to their senses.

"Hop, I have got to finish this grading by the middle of next month. You know that."

"Me know velly well."

"Now, I tell you what I am going to do for you if you get your men back to work tomorrow."

"No go back to work till Chinaman die and coffin filly up."

"Stop that nonsense, Hop. Listen. I will give every man full pay for lost time, and I will give you a bonus of one hundred dollars if they return to work tomorrow morning."

Hereupon Van Don went to his tent and brought out a buckskin bag containing one hundred silver dollars

and told Hop to count them. The engineer was enough of a psychologist to know that the sight of such a pile of silver, not to mention the "feel" of those hundred pieces of one, would probably arouse in Hop a determination to get action that would bring the desired result. Hop was no ordinary man. He had a jaw that spelled resolution. Being canny, he suppressed any evidence of desire to accept the offer. In fact, he shook his head vigorously. Would Hop throw away the chance to make a small fortune? It seemed to Van Don that Hop was about to do just that.

"Mista Van, you not know what you ask. Chinaman velly 'ligious, velly—what you call—supsticious. Maybe kill Hop if he try get China-boy back to work till coffin all filly up."

"See here, Hop, I—"

"Wait, please, Mista Van, wait! Will you give Hop wages of all men? Three day wages, five hundred men? Will you give wages all to Hop?"

"Why, yes, Hop, if you prefer it that way. I suppose you want to bargain a little with the men and make a little more than one hundred for yourself. I know you make a rake-off on their wages anyway."

Hop's eyes lit up.

"Good night, Mista Van. I go talk to China-boys."

Shortly afterward, Van Don retired and was soon sleeping soundly. Before he dozed off he heard Chinese voices as if in a babble of debate, and a voice that occasionally rang out above the rest. It sounded like Hop's. The engineer had been asleep about two hours when he awoke with a start. There was a piercing shriek, followed by a pistol shot. Then dead silence for a few minutes. Van Don had slipped into his trousers, when he heard the flap of his tent snap smartly three times. It was Hop's way of awakening him in the morning.

"Is that you, Hop?"

"Yes, Mista Van."

"What in hell has happened now?"

"Not sellious. One China-boy gone clazy. Kill self with pistol. Coffin all filly. All China-boy go to work to-mollow."

* * * *

Was it football training or heredity or both which saved the surveyors' prestige in the punk hotel?

STEPHEN JOHNSON, as we have seen, solved his engineering problem unaided by any of his engineering staff. Van Don's problem was turned over to an Oriental assistant, who solved it in a most unexpected though effective way. The next engineering problem in this series of three was quite as unique as the two just reviewed. Its solution was compassed in part by the chief of the party but in greater part by a rodman.

Engineer Hopkins had charge of a corps of fifteen who were surveying for a proposed branch of the N. G. in Montana. The party intended making its headquarters in a little town whose only hotel was more of a saloon than an inn. To make matters worse, the rates of charge—American plan—were too high for the incomes of all in the party except its chief, Hopkins; so, after one day's experience at the hotel, his corps of fifteen moved out and went to boarding houses.

Hopkins invited his transitman, his topographer and two others to come to his room at the hotel and play cards the evening after the exodus. The host in those days, upon such an occasion, usually provided beer and pretzels. Hopkins, lacking originality, did not attempt to establish a new practice, such as providing champagne. He blew down the speaking tube.

"Hello," came the answer to the whistle in the office.

"Send up a gallon of Pabst and a platter of baked snakes."

"Of what?"

"Pretzels."

"O. K."

The engineering corps forgot about the coming refreshments as they concentrated upon certain practical problems in mathematical probability, such as "Holding a straight open only at one end, what is the chance of filling?" "How many times in an hour is it probable that a player will hold a pat hand?" Whoever thinks this is not engineering knows neither the definition of engineering nor that probability is a science. "Engineering is the application of science to the problems of economic production." If it is not "economic production" to win at poker oftener than you lose, what is it? Let me add that the best treatise ever written on "the great American game" was penned by a West Point graduate who was a member of the army engineering corps when he wrote it.

Hopkins was a very expert surveyor, but even in those days engineering had become somewhat specialized, and Hopkins was not much of an engineering expert at poker. During a contemplative period following a sudden financial depression when his bluff was called, Hopkins realized that his order for beer had not been executed, so again he blew down the speaking tube. With irritation in his voice he asked why the beer had not been sent up, and resumed his playing. After a lapse of another ten minutes of no beer, he blew down the tube violently.

"Hello! Why the devil doesn't that beer come up?"

"The boss says he'll come up himself and tell you why."

Considerably puzzled by the reply and greatly nettled, Hopkins had just begun to deal the cards when the door opened and its casement became filled with the bulk of the hotel proprietor. The man stood six feet six inches high, a muscular giant weighing two hundred and forty pounds. His mere size was formidable enough, but his scowling brows and snarling mouth completed a perfect picture of "Nature in the raw."

"You want beer, do you, Mister Hopkins? Well, you can have it for yourself because you are a guest of my hotel. But these cheap-skate friends of yours who can't afford to eat in this hotel, they can't afford to drink here either."

It was evident that "mine host" was more than a bit drunk, so Hopkins tried to pacify him. Failing in this attempt, still Hopkins did not countermand his refreshment order.

"This is my room and these are my guests, and I want that beer."

"See here, little 'un, this room is part of the hotel that I own, and I pick my guests in it. You are O. K., but these loafer friends of yours have got to get out."

Hopkins was a small man who would not have lasted a minute in a physical encounter with the giant, and it so happened that none of his guests was big enough to put up an individual fight against "mine host." Collectively they could have overpowered him, had it not been that, like Napoleon, the giant had massed all his forces where the enemy was weakest. Back of him stood two husky bar-keeps, one husky waiter, and a still huskier cook.

"Now, get out, you bums!" shouted "mine host," advancing with doubled fists.

"Stop or I'll shoot!" yelled Hopkins, kicking his chair back as he rose and pulled, ready to fire. A shriek from the hall was followed by a dash of "mine host's" spouse to his aid. The aid consisted in seizing his coat-tails and pulling vigorously. The lady was no lightweight herself, but tractive power was in the discard at that moment. A team of mice could have dragged "mine host" out of the room without straining the harness.

The giant gone, the five engineers resumed their engineering researches. Lingering scowls gave way to laughter when Hopkins showed them the "gun" that had won the victory. It was his spectacle case. Not one of the ten witnesses of Hopkins' act had seen that he was aiming a harmless spectacle holster at the giant, thus confirming the psychological principle that much that we see is already in our mind. The engineers were still laughing when Jerry Sullivan entered. Jerry was a rodman, recently graduated with a civil engineering degree and a football experience that he still regarded as more interesting than all his mathematics and applied science.

"What's the joke?" inquired Sullivan as he took a seat on the bed. His Irish-American heart began pumping hard, and a flush of anger spread over his face. Turning to Hopkins, he said:

"Chief, do you still want that beer?"

"Yes."

"Do you want me to lick the giant?"

"Can you do it?"

"Yes."

"Yes?"

"Yes!"

"Then, yes."

Down the stairs went the six engineers, none of them now laughing, into the bar-room. The giant was back of the bar, serving drinks. He had recovered his nerve and was telling how he planned having Hopkins arrested for threatening his life. Rodman Sullivan to the bar, a seeker of justice.

"Draw six beers and send a growler up to room five," he said.

"I'm damned if I do."

"Good! I'm glad you've got your guts back, for I hate to fight a coward. Come out from behind that bar until I knock a yes out of you."

Whether it was the presence of a large audience of patrons or the absence of the pseudo-pistol in his face, the giant accepted the challenge. He had nearly killed a bigger man than Sullivan in that same bar-room two weeks earlier in a rough and tumble fight. Perhaps the vivid memory of that triumph revived his courage. Perhaps a sixty pound handicap gave added confidence. At any rate, he threw off his coat, rolled up his sleeves, spat on his hands, and prepared for battle. Young Sullivan drew off his sweater and his undershirt with it. He was good to look at—brown, hard, utterly fit. Hopkins wished that fate had been as kind physically to him as to Sullivan.

The giant was accustomed to fight the wrestling, punching sort of battle, technically called "rough and tumble," so he asked whether that was to be the game. Sullivan was willing, provided no blows below the belt were struck and no kicks were kicked. The code of honor having been agreed upon, the men squared off. No sooner were their arms raised, then Sullivan feinted with his left and crossed with his right to the solar plexus. His fist seemed to sink out of sight just below the wishbone. A less powerful man would have been knocked out, but the giant merely staggered and then came at Sullivan like a bear. A blow on the jaw halted him; another again to the solar halted him; once more to the head, another halt; but he was too heavy, too powerful and too fresh to be completely stopped. His great hands finally had one of Sullivan's arms in their grip. Like a gorilla he hung on to that arm, while Jerry flailed his ribs with his free fist, every blow bringing a grunt. Suddenly the giant's right leg shot upward; his knee caught Sullivan in the groin and he fell writhing to the floor.

"Foul! Foul!" yelled the crowd.

Only their shout of disapproval prevented the giant from leaping upon his fallen foe.

Sullivan slowly gained control of himself and rose to a crouching position. Then, quicker than thought, he propelled his 180 pounds towards the giant, head on. It was one of the flying tackles for which he had been famous. His head struck his foe above the belt but in the most vulnerable part of the human anatomy north of that equator. The giant was lifted off his feet by the impact and fell like a forest tree downed by the last stroke of an ax. But the vitality of the man was prodigious. Slowly he got up on his haunches and slowly rose erect. This was exactly what Sullivan wanted him to do. Several men in the crowd had shouted to Sullivan to leap on his adversary and finish him with his fists. But they had never seen a flying tackle before. Now they saw the second one of that species of soporifics, for Sullivan again launched his body at the giant. Again the crash of flesh on the floor, and this time "Sleep, Nature's sweet nurse."

When "mine host" opened his eyes and Sullivan asked whether the beer would be sent up to room 5, a whispered "Yes, coming right up," told the crowd that peace would reign again.

When the engineers had resumed their applied mathematical exercises in room 5 and were drinking a toast to Jerry, Hopkins said:

"Sullivan, I knew you were a great football player, but you never told me of your fighting ability."

"Well, you see, I'm a bit modest about that. Fighting runs in our family. Now that you ask me, I must tell you that my father's brother was John Sullivan, the champion pugilist of the world, before my mother's brother, Jim Corbett, knocked him out. Besides, I was raised on goat's milk."

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Highway Safety Conference, June 29 to July 2, 1936

A four-day conference on highway safety will be held at Iowa State College, Ames, Iowa, June 29 to July 2, 1936. This conference, which will be open to the public, is planned particularly for traffic officials in county, city or state departments; traffic managers of large fleets of trucks and cars; and the leaders and members of organizations interested in highway safety, such as county, city and state safety councils, motor clubs, Rotary Clubs, Kiwanis Clubs, Lions Clubs, the American Legion, Chambers of Commerce, public schools, and other agencies.

Every person attending the conference will be given an opportunity to take all of the tests given by Dr. Lauer in the examination of drivers and in the study of many of the psychological and physical factors related to driving as given in the laboratory and also as determined on an outdoor driving course.

A list of 13 notable speakers has been provided to address the conference and lead discussions.

AN "MH" CONTRACT IN ILLINOIS

Charles Kapschull, of Kapschull & Co., Contractor on the Job.

THE old woman in *Mother Goose,* "who had so many children she didn't know what to do," had nothing on Charles Kapschull of Deerfield, Ill. Not children, however, but an overload of employes is worrying Mr. Kapschull of Kapschull & Co., contractors.

Late last Fall, Mr. Kapschull put in the low bid for a road job near Long Grove in northern Illinois. The award was made about the first of April and the Illinois contractor went into action on project 184M W P M H, "M H" standing for man-hour. This is one of many jobs undertaken by the government to yield as many man-hours of labor as possible in an effort to solve the unemployment problem.

Specifically, the contractor is building 3.75 miles of highway, including drainage structures and a bridge, to connect the Rand Road in Cook county with an important paved highway in Lake county, known as Route 54. This cut-off will save much travel. The job must be done in 90 working days; 58,640 man-hours of labor must be used, and the contractor must, or at least should, make a reasonable profit.

As these several elements of the equation seem somewhat contradictory and as this is only one of many similar work-relief jobs in various parts of the country, it will be interesting to make a brief survey of Mr. Kapschull's methods.

"This is the first job that I ever undertook," he said, "where efficiency of operation was of secondary importance. My primary problem here is to distribute those 58,640 man-hours of labor properly."

Sheepsfoot Roller and Discs in Operation.

A 12-Yd. Scraper Just Completing the Loading Operation.

Skilled labor must be union and unskilled labor taken from the relief rolls. Union labor, of course, must be paid more than men on relief. It readily will be seen, therefore, that here is where the distribution and proportionment of the two classes of employes can make or break the contractor.

The cut-off follows an old gravel road for a short distance and then strikes across farm land, much of which is a low-lying bed of peat. In the 84,000 cu. yd. of grading involved, 33,000 cu. yd. must be borrowed to make a fill of approximately 5 feet across the peat bottoms. It is probable that the estimated "borrow" will have been increased by 6,000 to 7,000 cu. yd. before the job is finished. Before the grading could start much tiling was necessary; in addition to which there are 14 2 ft. by 2 ft. and 2 ft. by 3 ft. concrete box culverts. A concrete bridge will span Buffalo creek.

The contractor is using up most of his required man-hours of labor in drainage, concrete and incidental work. If the truth were known, he probably employs more watchmen and more office and camp labor than is necessary or would be desirable in a job where efficiency was the first consideration. He began the contract by tiling; then started his culverts; next, his bridge, and had been moving dirt about eight days when the accompanying photographs were taken on April 20.

A less experienced contractor than Mr. Kapschull, who is superintending the job in person, under the circumstances might have distributed more of the required man-hours of labor over the grading operations. On the contrary, labor has been cut to a minimum on that part of the job and efficiency seems to be the watchword.

Because of the low prices prevailing, the contractor had done no work for three years. "I preferred to let

The 12-Yd. Scraper Outfit Unloading at the Fill.

General View of the Operations. A Loaded Scraper Is Being Hauled to the Fill. In the Background Is a Bulldozer.

some one else lose the money," he explained. His old equipment was worn out. He decided to secure an entirely-new grading outfit. For digging and hauling, he installed a 12-yd. hydraulic scraper pulled by a 95-H. P. Diesel tractor; for spreading the material, a Diesel bulldozer, and for tamping a "sheep's foot" roller and discs pulled by a third Diesel.

"You are not using up many man-hours there," was suggested to the foreman.

"Man-hours!" he exclaimed. "That outfit, operated only by the driver of the tractor, is doing the work of eight men—a tractor skinner, a plowman and at least six truck drivers."

The outfit, he said, had been averaging 120 cu. yd. an hour since morning, making a 9-ft. cut through some high ground and dumping the material on the low-lying peat beyond. During the week ending April 18, in 72 working hours 6,200 cu. yd. had been placed.

"At that," remarked a conservative old-timer who was watching the operation and thinking of his experience in levee construction, "you don't get very far away from our old methods. You laugh at the obsolete wheeler pulled by mules, but what is that thing but the same old wheeled scraper made larger and pulled by a tractor? And what is that sheep's foot roller doing? It simply is imitating the pounding of the mules' feet on the fill in the good old days."

The concrete bridge is being built across Buffalo Creek —a creek that a real active buffalo could jump across at normal flow. The old-timer before mentioned couldn't see the need of an $18,000 bridge to span the stream.

It will be a rigid frame structure of reinforced concrete. Moreover, it will be a "skew bridge," with a 40-ft. span measured at right angles and a 60-ft. span on the "skew." The structure will have a 44-ft. roadway, a 5-ft. walk on one side, and substantial concrete hand-rails. Three hundred twenty-nine cubic yards of concrete will go into the bridge, together with 47 tons of reinforcing steel.

The contractor is boarding his men, of whom there are about 90 altogether, counting full-time and part-time labor. There is no money in running a table, but good, warm meals are satisfying and make for greater efficiency.

This new road probably will be paved later in the year. The plan is to lay a 20-ft. concrete slab, with 10-ft. shoulders and 3 to 1 ditch slopes. The right of way is 80 ft. wide in Lake county and 100 ft. wide in Cook county, which is metropolitan district.

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32 States to Undertake Highway Planning Surveys

Comprehensive highway planning surveys conducted by state highway departments, with the advice and guidance of the United States Bureau of Public Roads, are under way or about to be undertaken in 32 states. It is believed that the completed studies will point the way for the development of long-term highway programs and tax reduction.

These projects will include an inventory of every mile of passable road in each state, a study of the character and extent of traffic on the various roads, and a careful examination of highway costs, expenditures and revenues. The factors of capital cost, road life and maintenance cost also will be considered.

To cover the costs of the survey there will be available in each state 1½ per cent of the following funds, as apportioned to that state; the 1935 Public Works Fund as provided under the Hayden-Cartwright Act; the 1936 fiscal Federal Aid apportionments, and the Works Progress Administration Highway and Grade Crossing apportionments. In addition to these funds the state must match the monies of the Federal Aid funds used. A number of states have already arranged for separate W. P. A. projects, some of which have been approved.

It is expected that the survey will cover a full year. Analysis of the records, maps and other data accumulated is expected to take another year. The results of the survey and the analyses made will be developed into a report which carefully evaluates and outlines the complete highway picture. This program will substitute an acceptance of a perpetual and continuing obligation of maintenance and rebuilding when necessary for the present casual treatment of roads, year by year, with annual demands and appropriations.

RUSSIAN EXPERIMENTAL TARRED EARTH ROADS

By A. K. BIRULA,
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THE usual cheap method in U. S. S. R. of improving the earth roads on argillaceous soil is the addition of sand, gravel or similar local material. But the roads improved by these materials are not "all weather roads." Furthermore, some spacious regions of U. S. S. R. covered with lössial soil are almost completely deprived of the above mentioned local road building materials. Thus arose the problem of building the "all weather earth roads," using a little quantity of material which has to be brought from a great distance.

The laboratory experiments proved that the argillaceous soil treated with the bitumen or coal tar becomes rather watertight, resilient and has a high bearing capacity.

In the course of the last three years many experimental sections of bituminous and tarred earth roads have been constructed. Under the general direction of the author the coal tar of Donbas is used for treating the heavy loam soils.

The granulometric analysis of this soil gives the following content of particles:

Sand particles>0.05 mm	10-15%
Silt particles, 0.05-0.005 mm	60-70%
Clay particles<0.005 mm	25-30%
The content of the organic substance	6%
Plasticity (Atterberg)	22-25

The properties of the earth roads on heavy loam are very unsatisfactory. These roads are in rather poor condition in rainy periods and particularly in spring. In summer time the dense dust covering these roads is a great obstruction for the automobile traffic.

It was already mentioned that the products of the works of Donbas are used for the experimental roads.

The first product used was the crude tar. When it is transported to the job its viscosity amounts to 5-60 sec. (Hutchinson viscosimeter +25° C.). In order to attain the necessary tar viscosity 30-40 sec., a due proportion of pitch has to be added to tar.

The second product was the tar composed from pitch and antracene oil prepared in a usual hot manner in kettles on the job. For the construction of the experimental roads the mixing in place method is adopted.

The preliminary laboratory investigations had established that the optimal proportion of bituminous material to the quantity of the treated soil must be 7-9 per cent (in weight). This proportion has proved in the course of the service of the experimental roads to be quite satisfactory.

The thickness of the tarred course is adopted as 10-15 cm. Using 10 cm. of compacted course, it has been laid in one layer, and when 15 cm. in two layers.

Conformingly to the mentioned tar proportion, the necessary rate of bituminous material is for the course of 10 cm. 11 kg./sq. m., and for 15 cm. 16 kg./sq. m. For a kilometer of the road of 5.5 m. of tarred carriageway the necessary amount of the tar is 60 tons for one layer and 88 tons for the two-layer road.

The tarred earth road composed of one layer has been constructed using the following processes:

Construction Method: The construction begins with grading operation. The ditches are 0.40-0.60 m. deep. The carriageway having a tarred crust is 5-6 m. wide and has a 3 per cent crossfall.

Considering the injurious action of capillary water on the bearing capacity of the subgrade, the road bed is placed on a necessary height above the level of the ground water.

After leveling the surface of the road the soil is plowed and scarified with great accuracy, all the clods destructed, the roots and other admixtures taken out.

Then the surface of the road is considered ready for tar distribution.

All the designed rate of tar has been distributed in two portions. The Etnyer type of distributor has been used for the distribution.

On some little experimental sections, however, these operations have been carried out by hand hoses.

Since the hot method of operation has been adopted the tar was distributed in dry and rather hot weather (the temperature higher than +10° C.).

As the dry soil can not be mixed satisfactorily with tar and it rested cloddy in the crust, the addition of water had been used.

After the first and the second distribution the soil has been mixed with tar by blading operation, giving it a uniform structure and color.

The level road surface has been compacted then by a 10-ton roller.

It was found that the surface of the first experimental tarred earth sections was very slippery in wet weather. That is why it has been found necessary to spread screenings and to distribute the tar 1-1.5 kg./sq. m. over the road surface till the rolling is completely finished.

The sealing cover of this type has a sufficient roughness.

The observations of the last years proved the high riding quality of the constructed experimental tarred earth roads.

Some failures that happened in springtime are explained by a bad drainage in these spots. The flow of capillary water from below caused the great moisture of the subgrade and the fall of its bearing capacity.

The tarred earth roads are all weather roads and have no ruts in wet weather.

The results of experiments with tarred roads are very encouraging.

THE GEOLOGY OF GLACIAL SAND AND GRAVEL DEPOSITS

By D. G. RUNNER
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DURING the past decade in which road building has become of prime interest to practically every individual, the usefulness of sand and gravel in this field of work is generally recognized. Workable deposits of sand and gravel may be found in almost every State of the Union. Among these deposits the glacial formations of various types should be of especial interest to the highway engineer. These glacial sand and gravels are products of the Great Ice sheets which at various times covered the entire northern section of the United States, and caused the widespread distribution of these materials.

Fig. 1—Map of the United States Showing Approximate Area Covered by the Glaciers. (Modified after Tyler.)

The 1935 Minerals Yearbook of the United States' Bureau of Mines states that during 1934 there was sold or used by producers in the United States, a total of 116,611,689 short tons of sand and gravel. A large percentage of this tonnage was sold or produced in Illinois, New York and Ohio, three states in which glacial deposits are commnly found. It was thought that a brief description of the origin, type, and composition of these glacial deposits would be of interest to the highway engineer as well as to others. Since these materials are used in various types of construction, it should be interesting to know something of their locality and method of formation. This paper will deal chiefly with the deposits left by the continental ice sheets, together with brief descriptions of all types of glaciers.

Types of Glaciers

In general there are three main types of glaciers, that are named for their size and features. These types are: valley glaciers, piedmont glaciers, and finally the continental or ice-cap glaciers. Valley glaciers are of the type that most everyone has in mind when the subject of ice movement is mentioned. This type of glacier consists essentially of a basin which catches the snow and feeds the mass of ice moving slowly down a valley. Finally this body of ice melts and changes into a river or a smaller stream that is dependent for its size upon the volume of ice in the glacier. Geographically in the United States, this type of glacier is found only in the high mountain ranges of the west, chiefly in California, Oregon and Washington.

Piedmont glaciers are the remnant of valley glaciers that have descended from the valleys out onto the plains or footbills. This type of ice-body stagnates and melts upon reaching base level. Glaciers of this kind are not at all common, and are found mostly in areas of high latitudes.

The third and last type is called the continental glacier. It is this type of ice sheet that has affected the topography of the northern United States and it will be discussed more at length than the two preceding types of glaciers. The continental ice-cap, as its name implies, consists of great sheets of ice of vast thicknesses. Usually at their borders or edges, they level out into branches called "lobes." In the present time only two such ice sheets are known, the one at the Antarctic region and the other one covering the whole of Greenland. During past geologic times there were three such main continental ice-caps covering the northern part of the United States and Canada. These were, the Cordilleran in western Canada, the Keewatin in northern central Canada, and finally the Labrodorean in northeastern Canada. Reference to Fig. 1 will show the areal extent covered by these vast ice sheets in the United States. At various times these sheets of ice extended southward into northern United States, only to recede, leaving vast deposits of glacial debris that had been picked up en route.

The beginning of glaciers is to be found in the regions of perpetual snow fields. Here the snow lies the year round, and is not dissipated by evaporation or melting. This line of snow is called the "snow-line," and varies in elevation from place to place. For example, at the equator it is about 18,000 ft. and, of course, at the polar regions it is at or near sea level. As the snow and ice are accumulated, the sheet becomes thicker and more compacted and as the accumulated ice reaches great thickness it starts to move from the mountains down into the valleys. This movement progresses until the warmer climate causes the ice to melt thus forming rivers. In general this is the valley type of glacier. Essentially the same process is undergone by the piedmont glaciers with the exception that they gradually progress down onto a level plain forming a large area of nearly stagnated ice before melting.

This brings us to the continental or ice-cap glacier. It was during the Pleistocene, the final division of the Cenozoic era that the great ice age was extended greatly. It has been stated that during this period there was extensive glaciation covering about 8,000,000 square miles of the earth's surface. During this time the whole northern part of what is now Canada and the United States, was covered by these ice sheets.

According to Cleland[1] it was about 1827 when the rate of movement of these glaciers was first noticed. Some glaciers are known to move at the rate of 1 to 2 ft. per day, while some Greenland glaciers have been measured as moving up to about 50 or 60 ft. per day. This rate of travel is dependent upon several factors, among which are the steepness of the slope, thickness of the ice body, slope of the upper surface of the ice, etc. It has also been discovered that the center of the ice moves faster than the sides, and that the top moves at a faster rate than the bottom.

During the Great Ice Age, the great masses of ice from the three main centers of Canada moved slowly southward into the United States. The movement was of necessity slow, and several times changes in climatic conditions caused the ice to recede until another temperature variation again caused the advance southward. The chief geological work performed by these glaciers consisted in the erosion of existing land forms, transportation of the debris in, upon, and under the ice mass, and finally deposition as the ice melted and the glacier retreated. The ice in its movement eroded the highest points of the land, picked up boulders by "plucking," and incorporated rock masses and fragments into the body of ice. This erosive process included the sides of the valleys as well as the summits of the mountains. The amount of debris carried by the ice was dependent of course upon the distance traversed and the number of "round trips" incurred in the retreat and advance. Thus it has been shown that glaciers have been and are one of the greatest known agents of transportation. This ice movement scooped out the Great Lakes, and advanced as far south as northern Kentucky and Missouri. The five distinct glacial stages known to have invaded the United States are shown below. Data modified after Pirsson and Schuchert.

DIVISIONS OF PLEISTOCENE IN NORTH AMERICA

Glacial Stage	*Maximum Years*	*Minimum Years*
Wisconsin	40-95,000	30-60,000
Iowan	180,000	105,000
Illinoin	340,000	190,000
Kansan	660,000	330,000
Nebraskan	1,200,000	540,000

There are numerous estimates of the length of time the land was exposed to the ice, but it is believed the above figures give an accurate enough estimate for this paper.

Glacial Deposits

In a general way, the material carried by the ice sheet in its journey, was deposited upon its retreat due to climatic changes. This debris has been classified as to name and type, and for the sake of clarity these classifications are as follows:

Ice-laid	*Water-laid*
(a) Moraines	(a) Kames
(b) Drumlins	(b) Eskers
	(c) Frontal aprons

Brief descriptions of the above types of deposits will be given in the above order.

Moraines.—During the long-continued forward movement of the ice, the accumulated rock fragments in the bottom of the glacier became frozen in the crevasses and cracks, and became the "tools" with which the land structure was carved. Quite often huge boulders, carried on the top of the ice sheet, gradually worked their way towards the bottom only to become broken and crushed in the movement of the ice. As the climate became warmer the ice receded leaving the detritus. If the ice front remained stationary for comparatively short intervals, this debris accumulated in what is known as a terminal moraine. These moraines are composed of till or a heterogeneous collection of boulders, clay, gravel, etc. Here the material is unassorted, or stratified, and represents a conglomeration of materials of various sizes, mineralogical characters, and shapes. The topography as developed by moraines is illustrated in Fig. 2.

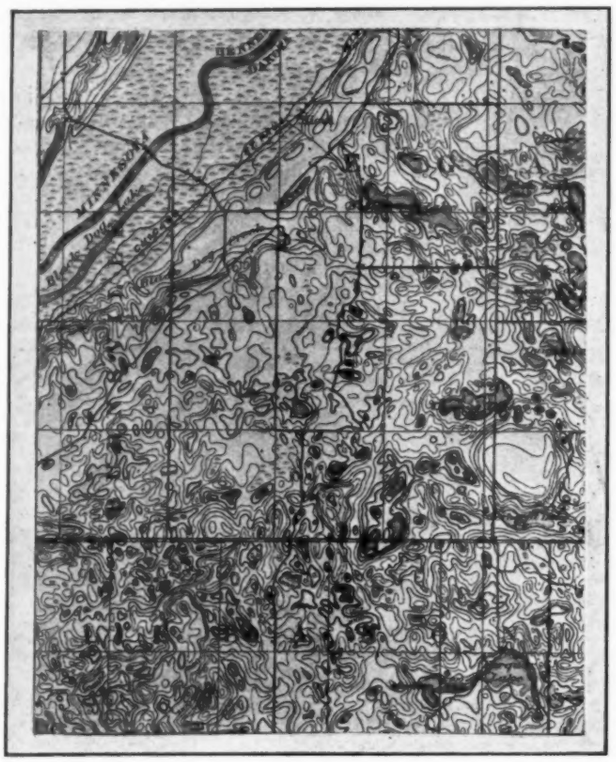

Fig. 2—Portion of St. Paul Quadrangle Showing Morainal Topography. Contour Interval 20 Ft.

Drumlins.—These are the second type of ice-laid glacial deposits, and they consist essentially of rounded, elongated hills, or short ridges with their longer axes pointed in the direction of the ice movement. This type of deposit is particularly plentiful in New York where thousands of them may be seen. An interesting description of these drumlins is given by Fairchild.[2] His description follows:

Drumlins are the second major ice-laid type of deposit, and derive the name from the Celtic, meaning "little hill." It can be seen that the name is very ap-

[1]Geology, Physical and Historical, by H. F. Cleland, 1916.

[2]Drumlins of Central Western New York, by H. L. Fairchild, Bulletin 111, New York State Museum, 1907.

Among the varied products of glacial work the smooth mounds and ridges known as drumlins are the most singular. They are the product of continental glaciers by the unique rubbing or molding action of the latter as plastic solids. In their form, attitude, composition and relation they are not only the most remarkable and interesting of the glacial drift deposits but in their graceful outlines and smooth surfaces they are the most striking and beautiful of drift forms, if not of all topographic forms of moderate size. Long before the glacial origin of the drift was established these smooth-outlined hills had attracted attention. They were cited as an objection to the theory of continental glaciation because they seemed inconsistent with the supposed planning and leveling effect of the ice sheet; and even up to the present time they have remained something of a difficulty if not a puzzle.

Fig. 3—The Esker of Punkaharju, Finland. In Scandinavia Such a Ridge Is Called an "Ose," Plural "Osar." (Reprinted by Permission from "Textbook of Geology" Part I, by L. V. Pirsson, Published by John Wiley & Sons, Inc.)

propriate as these drumlins probably never attain an altitude over 200 ft. Most of the drumlins found in New York are below 200 ft. in height and seldom exceed 1½ miles in length. The dimensions of course are dependent upon the quality and quantity of the drift and upon the depth and extent of the ice sheet. The common arrangement of drumlins, especially in a group, is with their long axes overlapping. Sometimes as one drumlin begins to "tail out," the slope of another one begins to rise. The material composing these drumlins is usually unassorted compact till, or boulder clay. The slow accumulation of materials, the gradual lowering of the debris through the ice sheet, together with falling of rock particles of all sizes compose the major portion of drumlins.

Kames.—This is a name applied to the peculiar deposits formed by the melting streams of the ice sheets. These deposits are knobs, short ridges, conical-shaped hills resembling drumlins, but differing in that they consist of semi-stratified material. Another distinguishing feature of these deposits is that they are usually arranged at right angles to the ice flow instead of paralleling the direction as in the case of the drumlins. Quite often they occur in groups, and some are known to reach elevations of 100 ft., although usually they are somewhat lower in altitude.

The ice sheet, in melting, caused the rock fragments, boulders, gravel, and the finer particles to pour forth in a cascading volume. In addition, the surface waters from the top of the ice carried debris to add to the general volume of material being accumulated. These and other conditions caused the resulting kames to consist chiefly of assorted clay, gravel, sand, boulders, etc. In general the stratification of the material was not of the best arrangement, for beds of gravel were usually intermingled with beds of clay, sand, or even other beds of gravel. It was common for the larger fragments of rock to tend toward decided angularity for the reason that they were not carried far by the water.

Eskers.—These are water-laid glacial deposits consisting essentially of long, narrow, winding ridges of mixed gravel and sand. They may range in elevation from 10 to 100 ft. or more, and have a width of 20 to 100 ft. The top ridge line is sinuous and trends in the general direction of the ice flow. These deposits were thought to have been laid as stream bed formations in the crevasses in the ice sheet. After the ice walls had melted, the material settled down in the "winding ridge" shape and at an angle of repose for gravel. These eskers have good development in the northern states, principally Maine. They are also common in Scandinavia where they are known to extend cross the country for miles. The material commonly associated with eskers is sand and gravel, boulders, in a somewhat stratified condition. Fig. 3 shows the typical development of the esker.

Frontal Aprons, or "outwash plains," as they are sometimes called, refer to the deposits of washed material from the melting ice cap. The melting of the ice and natural drainage of valleys produced streams charged with sediments. This washed down material was widely spread over broad plains in apron-like fashion, and the constant washing and movement of the water caused stratification of more or less intensity. Due to the large number of streams emanating from the front of the ice sheet, and to the probable level topography of the land, their ability to carry loads was considerably lessened, in which case a great amount of finer material was mixed with the gravel and sand.

Topography of Glacial Deposits

The topography resulting from the invasion of the great ice sheets is noted in different ways. For example, glaciated valleys of mountain regions are known by the characteristic U-shape in contrast to the V-shape exhibited by stream valleys. Reference to certain topographic maps of the United States Geological Survey, namely the Shasta, Calif.; Glacier Peak, Wash.; Cloud Peak, Wyo., and Mt. Stuart, Wash., will clearly show the characteristic topography caused by mountain glaciers.

Drumlin topography is distinctive as is shown in Fig. 4. Note the oblong and rounded mounds, and the trend of the long axes toward the direction of the ice move-

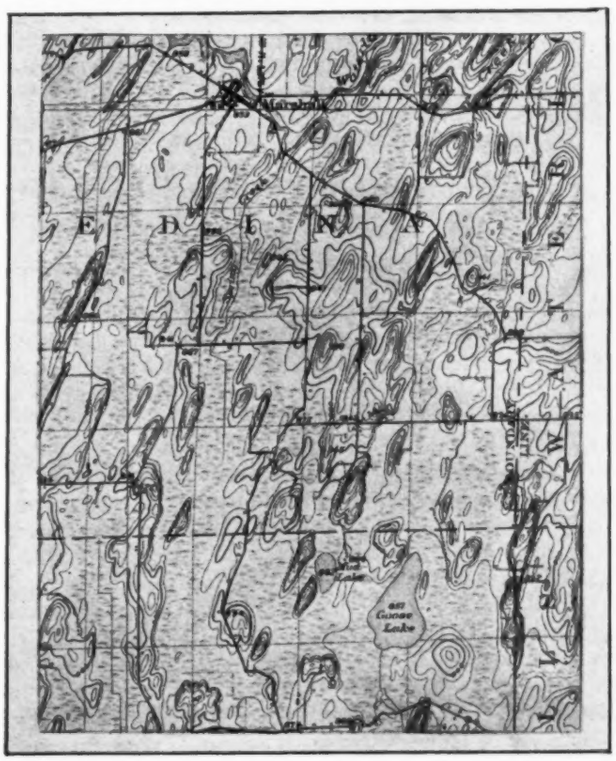

Fig. 4—Portion of Sun Prairie Quadrangle Showing "Drumlin" Topography. Contour interval 20 Ft.

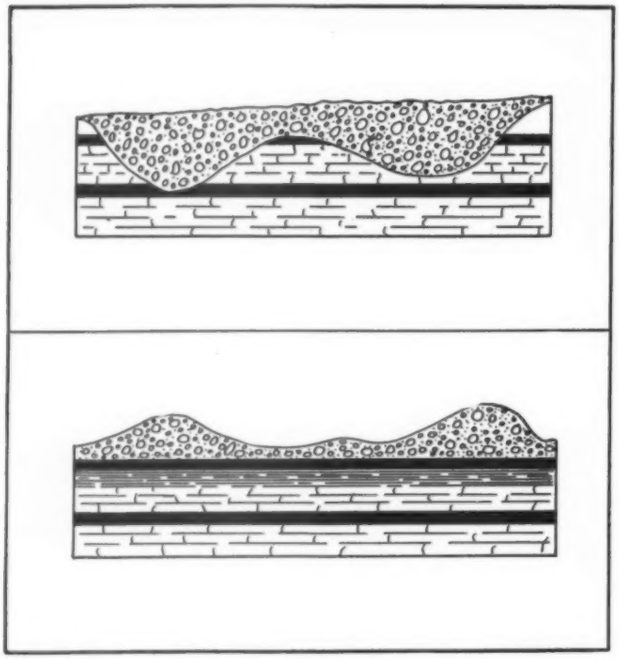

Fig. 5—(Upper) Diagrammatic Sketch Showing a Region Made Smooth by Glaciation. (Lower) Sketch of a Region Made Smoother by Glaciation

ment. These typically oval-shaped deposits are truly one distinctive feature of a glaciated region.

Eskers are relatively thin winding ridges of moderate elevation. Sometimes they cross valleys or even curve around hills. It is quite probable that the peculiar winding characteristic exhibited by these eskers was due to the fact that the material was deposited in channels in the irregular ice crevices.

Kames exhibit typical oval or irregular-shaped knolls and/or hummocks while morainal deposits have the topography as shown in Fig. 2. Note the irregular-shaped depressions, and knolls, also the unusual number of small bodies of water. Fig. 5 shows how the land surface may be made smooth or rougher by glaciation.

Character of Material in Glacial Deposits

The preceding brief descriptions of glacial deposits were presented with the purpose of acquainting the highway engineer with the principal types of topography caused by the ice invasion. With respect to the character of the material in these deposits, it may be recognized how likely they will be variable and inconsistent. For example, it is quite possible to find fragments of igneous rock, chiefly from Canada, intermingled with shale or slate from Vermont. The ice was no respecter of locality or material, but treated all with marked similarity. The loose existing soil mantle, as well as the rock foundations beneath, were picked up and moved irresistibly along with the ice. The particles of rock after being released by the melting ice, were in general, angular for the reason they originated through fracturing and crushing rather than by disintegration. However, some of this angularity was removed during the varied amount of water transportation incident to its deposition. As is well known, a large percentage of glacial debris now found in northern United States, is composed of material from the rock strata of Canada. Although the type or character of the material over which the ice moved before its retreat also has a decided influence upon the ultimate composition of the glacial deposits.

In addition, the aggregate within the deposit may vary in size from particles of clay-size to boulders, depending upon the features incident to the formation. If an area of granitic rocks had been scoured by the ice cap, it is highly probable that the deposit will produce medium to fine material for the reason that the parent rock is compact, reasonably durable, and would tend to fracture into small fragments. The necessity for a thorough study and investigation of glacial deposits before attempting commercial production, is readily seen. However,

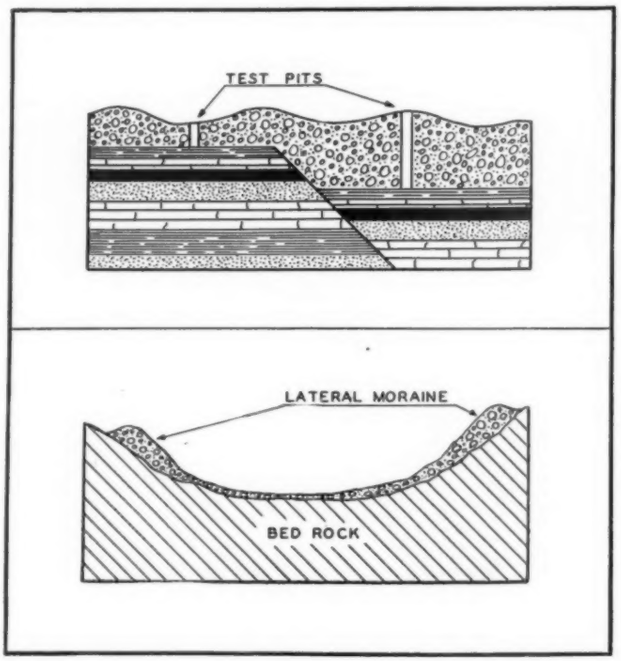

Fig. 6—(Upper) Sketch Showing the Possible Variation in Thickness of Glacial Deposits in a Faulted Region. (Lower) Cross Section of a Moraine Showing the Possible Variations in Thickness of Glacial Deposits

numerous sand and gravel plants are operating in glacial deposits. A few such plants, as reported by the United States Bureau of Mines, will be found in the reference list to this paper. Figure 6 illustrates how important it is to make a complete examination of glacial deposits before starting production of sand or

Fig. 7—View of an Old Glacial Delta. Note the Topset and Foreset Beds. (Photo from "Determining the Suitability of Aggregates for Concrete Pavements" by Gonnerman and Ward)

gravel. Fig. 7 is an old glacial delta, showing the topset and forset beds.

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Arizona Highway Department Builds Monument to "Hi Jolly"

Rising out of the Arizona desert the monument shown below perpetuates the name of the man who drove the only camel caravan ever to trek this land.

In Greek, the man's name was Phillip Tedro; in Arabic, Hadji Ali. But in the lingo of his friend the American soldier, Phillip Tedro, alias Hadji Ali, was just plain "Hi Jolly."

There was magic in the way Hi Jolly handled his majestic charges. And Hi Jolly, had he been alive at the time, would have seen magic in the "pen"—the electric arc—which wrote his epitaph with molten steel.

More about Hi Jolly is told by the builders of his monument, the Arizona Highway Department:

"The famous camel herd with which the name of Hi Jolly is linked constitutes an interesting sidelight of Arizona history. Jefferson Davis (afterward President of the Southern Confederacy) as Secretary of War approved a plan to experiment with camels for freighting and communication in the arid southwest. Major Henry C. Wayne, of the U. S. Army, and Lieut. D. D. Porter (later a distinguished admiral of the Civil War), visited the levant with the storeship 'Supply' and procured 33 camels, which were landed at Indianola, Texas, February 10, 1856; 41 were added on a second voyage. With the first camels came, as caretaker, Hadji Ali, whose Arabic name was promptly changed to 'Hi Jolly' by the soldiers, and by this name he became universally known. His Greek name was Phillip Tedro. On the Beale expedition (1857) to open a wagon road across Arizona from Fort Defiance to California, the camels, under Hi Jolly's charge, proved their worth. Nevertheless the War Department abandoned the experiment and the camels were left on the Arizona desert to shift for themselves, chiefly roaming this particular section. They survived for many years, creating interest and excitement. Officially, the camel experiment was a failure, but both Lieut. Beale and Major Wayne were enthusiastic in praise of the animals. A fair trial might have resulted in complete success."

Photos, courtesy The Lincoln Electric Co., Cleveland, O.

Monument Erected in Honor of Hi Jolly by State Highway Department of Arizona, and Close-Up of Plate.

GOVERNMENTAL INVESTIGATION OF WEATHER CYCLES AND THEIR CAUSES

By HALBERT P. GILLETTE

AT LAST our government has begun a research on weather cycles that bids fair to be a thorough one. Henry A. Wallace, Secretary of Agriculture, has just announced that funds have been allocated for this purpose from the Bankhead-Jones appropriation for researches affecting agriculture.

Apparently this research is sponsored by Mr. Wallace and not by the Chief of the Weather Bureau, Mr. W. R. Gregg. The latter recently returned from a national conference of meteorologists in Europe at which little hope was expressed that weather cycles would prove useful in forecasting. It was the consensus of opinion that such cycles exist, but that they are not regular enough to be useful. This is a very poor excuse for the pessimism as to cycles so prevalent among governmental meteorologists. They admit the existence of cycles, but, failing to understand their idiocyncrasies, they give up in despair!

Our Weather Bureau has been notoriously apathetic toward cycle research. It has never conducted any tree-ring or annually laminated-silt (varve) measurements. The writer has never seen any publication of such measurements in its magazine, The Monthly Weather Review. Man-kept records cover such a brief time that the only hope of solving problems involving long weather cycles lies in Nature-kept records, yet that hope has been cast aside by the Weather Bureau and left to enterprising individuals like Douglass, Huntington, De Geer and Antevs.

Secretary Wallace not long ago said that if a large private corporation like the A. T. and T. had an important research problem to solve, it would not hesitate to spend a million dollars annually upon it, whereas our government had seemed indisposed to spend even $1,500 annually.

The very fact that cycles are known to exist, but are also known to have been unreliable as aids in forecasting, is reason enough for seeking a better knowledge of them. This means, first of all, to ascertain the average length of every cycle with the greatest attainable accuracy. That obviously involves using tree-rings and annual silt varves covering thousands of years.

The next step must be the testing of every conceivable hypothesis of the causes of cycles, for until the causes are known, cycles are likely to remain of little utility. But right at the very threshold of an investigation of causes, nearly all meteorologists agree that it is not worth while investigating any but thermal, gravitative and inertial causes. Yet no one claims meteorological science to be even reasonably satisfactory. Its goal is forecasting, and its forecasting is the subject of endless jests. Only the other day a celebrated columnist said that at a banquet attended by authors he sat beside the local weather forecaster who is an author of "much light fiction."

Michael Faraday, the most celebrated researcher in electricity and magnetism, advocated a magnetic theory of certain air-currents (Researches, Vol. 3, p. 265) yet not a single meteorological book or article that the writer has read even mentions that theory. Was Faraday such an impractical dreamer as not to be worthy of attention? Or have meteorologists been so completely obsessed with the assumed sufficiency of the convection theory and its affiliates as to lead them to search for no other cause of air movements? Whatever the reason it lacks justification, for a "sine qua non" of successful research of this sort is the study of many different hypotheses—the multiple hypothesis method advocated by Chamberlain and by many other researchers.

The writer, after much study of the subject, believes that climatic and weather cycles are due to periodic changes in the number of solar electrons that enter the earth's atmosphere. He believes that the periodicity is due to the gyrations of the axes of electron-shells that encase both sun and earth, as well as to periodic changes in the direction of the axes of sun and earth toward one another. The latter, for example, should cause a climatic cycle of about 26,000 years, and Bradley has fully established the existence of a cycle of that order of length in the oil-shales and marls of Colorado. Bradley measured only a few hundred of those varves. Let the government measure several thousand—26,000 if possible—and the cause of that cycle will undoubtedly be found by finding its length. Ascertain, beyond doubt, the causes of one cycle, and the causes of others will probably be found to be similar. Since the sun's axis doubtless gyrates (perhaps in about 1,000,000 years), a cycle of a few hundred years longer than the gyratory period of the earth's axis probably exists. It certainly exists if the solar electronic hypothesis is sound.

Dr. Ellsworth Huntington of Yale was the first (1922) to advocate a solar-electron hypothesis of weather cycles. Dr. Benjamin Boss, the astronomer, later (1930) adopted it with some modifications. The writer has also adopted it and has added the hypothesis of gyrating electron-shells to account both for sunspot and weather cycles.

Dr. George Ellery Hale has established that the sun is charged with electrons. We know that electrons are constantly emitted from the earth; hence strong analogy supports the belief that they are emitted from the sun. We know that sunspots, aurorae and magnetic storms are correlated. We know that the earth is encased in several electron-shells. We know that electrons act as nuclei of raindrops. We know that electrons moving in a magnetic field travel spirally around magnetic lines of force. We know that sunspots are rotating vortices. We know that nearly all winds are also rotating vortices.

In short, if one's eyes were not averted from certain facts, it would be impossible to ignore so completely an electronic hypothesis of weather cycles as to refuse to investigate it most thoroughly.

A NEW LOW-COST SURFACE

Simplified Methods of Mixing and Laying Bituminous Materials in Cranston, R. I.

By ELTON F. DURFEE

Commissioner of Public Works, City of Cranston, Rhode Island

A NEW and very satisfactory type of pavement developed by the City of Cranston, R. I., is similar to the mixed-in-place type but has proved to be more durable and also cheaper. The aggregate is the same as previously used in the mixed-in-place method but is pre-mixed by steam shovels at the source of supply.

Due to a demand for a better type of pavement and the lack of adequate funds, experiments were made in pre-mixing; and from the experimental stage we now have about 92,000 sq. yd. of pavement constructed. Some of this work has stood through two summers and three winters without being affected by either extreme cold or heat. The temperature during this period has ranged from 20 degrees below zero to 100 above. The aggregate is a fine run gravel or a coarse sand, the best results having been obtained by separating the sand and stone aggregate for the bituminous top. In this way we make use of the entire run of the gravel bank.

Applying Tarmac to Aggregate. The conical pile is practically complete, and shovels are ready to start final mixing

Mixing Methods and Equipment

The mixing process is carried on in the following manner. The shovel is located at the gravel bank, where a full bucket is taken and dumped at about right angles. As each bucket is dumped the new pile forms a natural cone-shape. Bituminous binder (tar) is sprayed on this cone continuously by a 30 ft. pipe connected to the distributor. This pipe rests in the center on a frame with an oar lock to give freedom of action in all directions. On the other end of the pipe is an arrangement of ordinary hand hose nozzles set in a T form.

The pile of aggregate is coated with a fine spray of bituminous binder, correct proportions being obtained by counting the number of full buckets from the shovel, and applying the bitumen at a rate of 16 gal. per cu. yd. for coarse aggregate and 20 gal. for fine aggregate, with an average of 18 gal. for most of the aggregate. After the load of tar (usually 1,000 gal.) has been sprayed over the cone-shaped pile, the shovel starts the mixing process. This is done by cutting through the pile a few times with the shovel gate left open. Then the gate is closed and the mixed aggregate rolled from the front to the back of the pile. When the aggregate is thoroughly mixed the pile is thrown back out of the way and left as stock until needed.

One shovel will incorporate the 1,000 gal. of tar and the aggregate in approximately 40 minutes, thus making about 55 cu. yd. of paving material. On a large job completed the past summer 3 shovels were used—2 for mixing and 1 for loading the mixed material on the trucks. With a haul of 5 miles we were able to lay at an average rate of 870 sq. yd. per hour. The State of Rhode Island provides specifications for tar for this class of work under the designation "DM." Cut back asphalts have been experimented with successfully, but

Spreading Pre-Mixed Materials with Nickerson Spreader, September, 1935

asphaltic emulsions have proved a complete failure. The surface above described was laid on a 6 in. gravel base. The subgrade included a variety of materials—loam, gravel, sand and clay.

Summary of the Cost of a 2-in. Bituminous Top Used on 13 Streets in the South Auburn District

The following is an accurate cost record kept by the engineering department, in which the actual value of city equipment was figured on a basis of rental of the same equipment.

Aggregate. The material used was screenings purchased at 30 cents per cu. yd. in a stock pile at a gravel plant. They included everything passing a 1-in. screen. Three shovels were required in the mixing process, a 1 yd. shovel for leading trucks and two ½ yd. shovels for mixing. The shovel loading trucks was also used for mixing when no trucks were ready. The shovels were operated from 9 to 10 hours per day in order to keep a sufficient supply of mixed material for the next day's delivery. The cost of each shovel was $50.00 per day, including operator, fireman and fuel. The cost of mixing also includes wages for 4 laborers at 50 cents per hour and one foreman at 60 cents per hour.

Hauling. The average haul was 5½ miles. Six trucks of 5 cu. yd. capacity at $2.00 per hour were employed, also, 4 trucks of 4-cu. yd. capacity at the same rate.

Spreading and Rolling. On this portion of the work 2 foremen, 1 timekeeper and 10 laborers were employed. A Nickerson spreader loaned to the city by a local contractor was used to spread the material, after which there was a final raking by hand. No charge is included for the spreader. Material was laid 2½ in. loose, and tests made after rolling was completed show not less than 2 in. at any place and in some instances a great deal more. A 10-ton roller was used. We have found a tandem of this weight more satisfactory than a 3-wheel roller. The average number of square yards per cubic yard was 15.37. The cost figures given were based on rental values of equipment. The actual cost for the city was 2½ cents per square yard less.

Time. Two shovels started mixing on the day before the hauling started. Spreading of the 39,520 sq. yds. was completed in 49 working hours (7 days at 7 hours per day).

Truing Up the Spread Materials by Hand, September, 1935

Cost Details

Materials, Mixing & Loading	*Quantity*	*Unit Cost*	*Total*	*Cost per sq. yd.*
Tarmac	49,910 gal.	$0.1099	$5,485.11	
Gravel	2,781 cu. yd.	0.30	834.30	
Cost of Mixing and Loading			1,437.50	
Total			$7,756.91	$0.1818
(Total number sq. yds. mixed—42,670)				
Hauling				
10 trucks	517 hours	$2.00	$1,034.00	$0.0262
Spreading and Rolling				
10 Men, 2 Foremen, 1 Timekeeper & 1 Roller			$ 429.50	$0.0108
Total Cost per square yard				$0.2188
(Total number sq. yds. spread—39,520)				

Rolling the Pre-Mixed Materials. Traffic has partially ironed out the surface at left in picture

The apparent discrepancy between the 39,520 sq. yd. laid and the 42,670 sq. yd. mixed is accounted for by the fact that the equivalent of 3,150 square yards of mixed material was taken from the stock pile and used on patching work. There was ample time for the men working on the streetes and trucks to have used this amount of material so that the full 42,670 yards could have been laid at the cost shown.

Number of Gallons Tar per sq. yd.—1.17

Cost of Tar per sq. yd.	$0.1285
Cost of Gravel per sq. yd.	0.0196
Cost of Mixing per sq. yd.	0.0337
Cost of Hauling per sq. yd.	0.0262
Cost of Spreading per sq. yd.	0.0108
	$0.2188

Advantages of the Method

We have found the following advantages in using this method:

1. With a tar binder we were able to bring the viscosity of the tar used from 50 at 50°C. to as high as 70 at 50°C., and we hope in further experiments to increase the viscosity still further. By use of the higher viscosity tar we have a much denser, quicker-setting pavement; and it is believed the durability is increased accordingly.

FOR 32 years Tarvia has been helping thrifty communities put the "Good Roads at Low Cost" principle into practise. With Tarvia they build roads to meet immediate needs—smooth, easy-riding, skid-safe roads which can be easily and quickly widened and strengthened when traffic volume increases. Costs are impressively low, and there is never any need for heavy bond issues and sky-rocketing taxes. Ask the Tarvia field man.

THE TECHNICAL SERVICE BUREAU
of The Barrett Company invites your consultation with its technically trained staff, without cost or obligation. Address The Technical Service Bureau, The Barrett Company, 40 Rector Street, New York.

Central Street, Winchendon, Massachusetts. Tarvia-built, 1915. Only the simplest, most inexpensive maintenance has been necessary to keep this pavement in perfect condition through 21 years of ever-increasing traffic.

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GOOD ROADS AT LOW COST

THE BARRETT COMPANY New York Chicago Birmingham Philadelphia Boston St. Louis Cleveland Minneapolis Lebanon Milwaukee Detroit Baltimore Columbus Youngstown Toledo Buffalo Providence Syracuse Hartford Cincinnati Bethlehem Rochester Portland, Me. Norwood, N. Y. In Canada: THE BARRETT COMPANY, LTD. Montreal Toronto Winnipeg Vancouver

A Completed Surface of Durfee Method Pre-Mix Tar-Gravel in Cranston, R. I.

2. The aggregate is thoroughly mixed and not one particle of the sand can be found in a completed batch that has not been completely coated with tar. The small stones are embedded in this mastic so that there isn't any chance of the stone pulling out. There is no chance for any fat spots or for any lean mixtures, as the entire product is thoroughly mixed before being placed in the stock pile.

3. Material can be mixed and left in a stock pile for any length of time, and will not harden except for a thin crust that forms on the outside. This crust is mixed and used with the rest of the material without any deleterious effect. We have left this material in a stock pile through the winter and found it in good condition in early Spring.

4. Mixing can proceed in any weather. We have successfully mixed with the thermometer 10 above zero and also in a light rain. The sand does not have to be heated or kept dry.

5. The pre-mix material can be laid to any line and grade similarly to sheet asphalt.

6. Work can progress without stopping traffic. The more traffic that goes over the pavement between the time it is laid and when it is finally set, the better the pavement. In several instances we have used city trucks to run back and forth over the pavement for the purpose of rolling.

7. There is no messy tar to be spread on the street to be picked up by passing vehicles or pedestrians.

8. During the past summer we successfully demonstrated before engineers representing all of the New England States that this pavement can be mixed and laid at the rate of 870 sq. yds. per hour.

9. The finished pavement is practically skid proof. Tests made on this pavement while wet showed no signs of skidding whatever.

10. This material makes an excellent patch and can be used under water if necessary.

▼

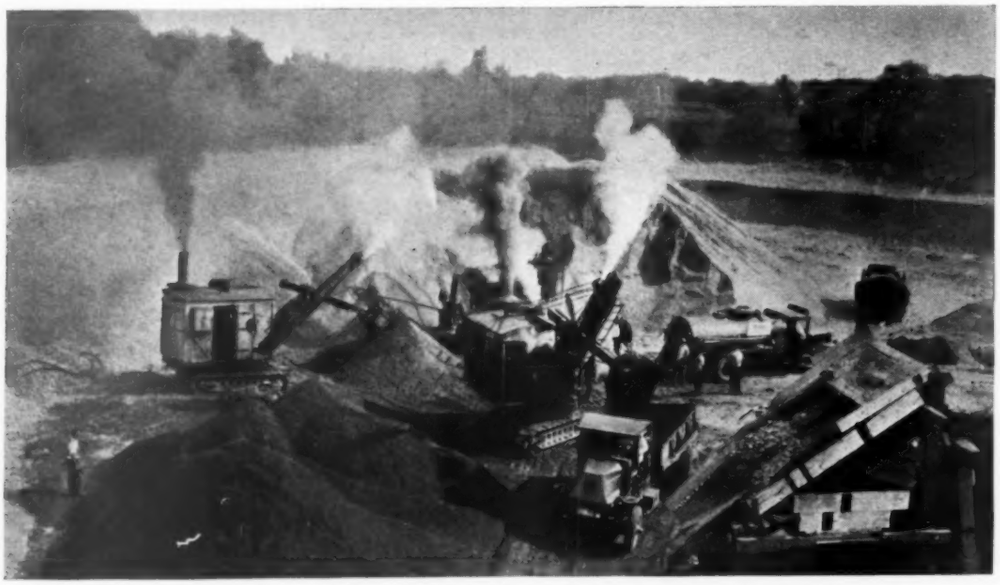
A. S. T. M. Meeting in June

The American Society for Testing Materials will hold its annual meeting at Chalfont-Haddon Hall, Atlantic City, June 29 to July 3.

On the program, two sessions are scheduled on cement and concrete. They will feature papers dealing with a hydrometer method for determining the fineness of portland and puzzolancements, new data on the hardening of cement mortars, rating characteristics of fresh concrete, effect of testing speed on strength and elastic properties of concrete, the relationship between the elastic properties and linear change of stone in the natural state to concrete specimens containing the same stone, and cone method for determining the absorption by sand.

Several contributions are to be included in the annual meeting program covering the subject of soils including papers on testing and design of stabilized soil mixtures, sampling and testing of foundation soils, internal stability of granular mixtures, and the determination of the approximate percentage of moisture in soil samples without drying.

One of the high lights of the meeting is scheduled for this session in the paper on "Failure of Suspension Bridge Cable Wire" by W. H. Swanger and G. F. Wohlgemuth, National Bureau of Standards.



General View of Plant—Three Shovels Operating—September, 1935

HAULS 600 TONS DAILY

Truck being loaded at mine of Industrial Coal and Iron Co. in Southern Ohio

COAL MINE TRUCK CARRIES 31-TON LOADS • • • NEVER TOUCHES PAVEMENT—TIRES TAKE IT

Six hundred tons of coal hauled is just a day's work for one of these big trucks. Five such semi-trailer units are constantly on the go. They're loaded in a hurry by big, powerful electric shovels. Then, after leaving the stripping operation, they drive through mud and water—over stones. They never see a paved road. And the gross load is over 31 tons. What a job for tires!

Tires Triple Protected

Yet Triple Protected Silvertowns take the trucks through with never a letdown. Not one sidewall break is chalked up against them in over a year!

It's that kind of service that leads truckers to choose Triple Protected Silvertowns for their toughest hauling jobs. And if they stand up under the brutal, grinding service of a strip mine, they'll save money on your trucks, too.

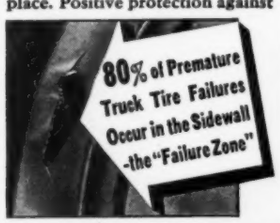
Here's the secret of Goodrich performance. Every Silvertown is built with a new invention in the sidewall. This development—Triple Protection—provides a 3-way safeguard against sidewall breaks—the cause of 80% of premature failures! When you get this protection, you've gone a long way toward getting tire costs down to bed rock. Don't take chances. Insist on Triple Protection when you buy. It costs you *nothing extra.*

HOW TRIPLE PROTECTION WORKS

1 **PLYFLEX**—a *new*, tough, sturdy rubber material with greater resistance to stretch. A layer of Plyflex in the sidewall prevents ply separation—distributes stresses—checks local weakness.

2 **PLY-LOCK**—the new Goodrich way of *locking* the plies about the bead. Anchoring them in place. Positive protection against the short plies tearing loose above the bead.

3 **100% FULL-FLOATING CORD**—Each cord is surrounded by rubber. With ordinary cross-woven fabric, when the cords touch each other, they rub—get hot—break. In Silvertowns, there are no cross cords. No friction.



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Goodrich *Triple Protected* **Silvertowns**

SPECIFY THESE NEW SILVERTOWN TIRES FOR TRUCKS AND BUSES

SURVEY OF COUNTY ROAD CONDITIONS BEFORE RESURFACING

By GEORGE GAULT,
Wayne County Surveyor,
Richmond, Ind.

A GREAT many mistakes in road building and road maintenance might be avoided if a careful survey of road conditions were made before the work was started. We are interpreting the word "resurfacing" to mean any change in the surface of the road from the time that the first vehicle passed over the road. In most cases it is not possible to take the time to run a transit line and a line of levels and cross section the road which it is proposed to improve. Much information can be obtained by simply observing the road at different times of the year and in different kinds of weather. These observations should develop the following information:

1. Whether any changes in alignment should be made.
2. Whether any grade changes should be made.
3. Whether any additional right of way is necessary.
4. The general drainage of the right of way.
5. The condition of all drainage structures.
6. The character of the subgrade and present surface.

These points are not listed in the order of their importance, but rather in the order in which they should be considered, and we will, therefore, discuss them briefly in the order named.

Alignment—Motor vehicles are being made to travel at higher rates of speed each year and heavy trucks are now being driven over our roads at higher speeds than the light passenger cars of a few years ago. We all know that the wear on the road surface is much greater on curves than on tangents. It is often possible to shorten the road by the elimination of sharp bends and save enough in the cost of construction and maintenance to justify the purchase of the land which may be necessary to make the change. This is in addition to the safety of the traveling public which will be greatly improved by the straightening of the road. If it is not possible to eliminate the curves or sharp bends we should make the curves of as great a radius as possible, and give the proper super elevation to the roadway. If time and funds permit, we believe it will pay to run a straight line on roads which appear to be straight. It will generally be found that some irregularities exist in the present road, and by changing the width of the material added to the berms at different locations the general appearance of the road can be greatly improved. The alignment of any connecting or cross roads should be considered and provision should be made for any changes in their alignment which may be made in the future.

Grade Changes—Improvement in alignment as outlined above will not be of much benefit if we permit sharp changes in the grades to obstruct the sight distance of the motorist. The greater part of our roads were originally laid out with practically no grading and it was only necessary that the grades be such that they could be climbed by a horse. When wagons were used for transporting loads over the roads it was possible to limit the loads to the load that could be pulled over the road and the question of safety did not enter into the discussion as to how much a hill should be cut down. Now we find that many of these roads have been improved by a gravel surface and no attention has been given to the safety which is so necessary with our modern vehicles and rates of speed. We hesitate to destroy this gravel surface by cutting down the hill and raising the fill through hollows.

These situations have been corrected on our main state highways and the average motorist upon leaving the state highway forgets to reduce his speed and in too many cases provides work for the county coronor. By the use of vertical curves it is often possible to greatly improve the safety of the road with only slight expense. The approach grades to bridges should be given consideration not only to prevent undue strain on the bridge but also as a matter of safety. The approach grades to railway crossings should be made so that a level space will be provided on which the motor vehicle may be stopped before crossing the railroad. Approach grades to heavily traveled highways should be treated in the same manner as the hazard at such crossings is greater than that at the railroad crossings. The grades of connecting or cross roads should be given consideration and any changes which can be made in the road to be improved that will improve sight distance on these roads should be made. Again, if time and funds permit, we think that a profile showing elevations on the road at each 100 ft. will be worth much more than it costs and will make it possible to greatly improve the appearance of the road.

Right of Way—The general width of the right of way on the county roads in our county, which were formerly township roads, is about 30 ft. This is hardly wide enough to provide for an improved road with proper drainage and we have secured an additional 5 ft. on each side where any extensive improvements have been made. As it is highly desirable that someone keep the weeds mowed on the roadsides, we do not think it advisable to take any more right of way than is absolutely necessary

BUCYRUS-ERIE

owners are enthusiastic boosters. Say Myers and Goulter of Seattle: "We have purchased, in the past 12 years, 9 Bucyrus-Erie shovels, 8 of them Diesels. Have used other makes but the 37-B Caterpillar-powered Diesel we purchased last August is the best 1½-yard shovel we know of. When we purchased the 37-B we thoroughly investigated other makes, then gave you the order. After months of use, a considerable time in the hardest of material, we still feel the 37-B is the best buy on the market."

Two of every three Bucyrus-Eries go to owners who know from actual experience that a Bucyrus-Erie is always the most profitable buy. You too can profit by Bucyrus-Erie big output performance. Send for the bulletin on the size you need.

BUCYRUS ERIE

EXCAVATING, DRILLING, AND MATERIAL HANDLING EQUIPMENT...SOUTH MILWAUKEE, WISCONSIN, U.S.A.

for the proper maintenance of the road. During the time that we have had relief workers on the roads we have moved the road fences back with no expense to the land owners for labor. The land owner either furnishes new posts and fence or we move the existing fences back to the new line. It is usually possible to secure the consent of the land owners to make these changes without paying for the land. If they insist on being paid we skip this part of the road and go ahead and improve the other parts. Before the balance is completed we have always been requested to come back and complete the road and we get the right of way without further trouble. While it may not seem that the right of way has much bearing on the resurfacing, we do not think that it is of any use to resurface a road unless the right of way is such that the road can be efficiently and economically maintained.

General Drainage—Many of our roads have been drained by digging a ditch of a certain width and of uniform depth below the surface of the road without any provision being made for the water to get out of these standard ditches. The result is that the water lays in these low points in the side ditch for a long time after the remainder of the road has dried out. This frequently results in permanent damage to such surface as may be on the road and such conditions should certainly be remedied before any resurfacing is done. We believe that the width of the road from shoulder to shoulder should be kept uniform but the width and depth of the side ditch should be such that the water will all move to a permanent outlet without damage to the road. If it is not thought possible to have levels set for these ditches it is a good practice to drive over the roads either during or immediately after a heavy rain when the defects in the drainage will be very noticeable and notes can then be made showing the points to be improved by drainage. After the draining has been completed it is a good idea to drive over the road again after a heavy rain and see if any further improvements can be made. If any wet spots remain in the road in dry weather, the cause should be investigated and either French Drains or perforated pipe installed if necessary.

Drainage Structures—Before any resurfacing is done we believe that all drainage structures should be examined and, if it seems probable that all or part of these structure will have to be replaced before the surface which it is proposed to apply is worn out, the replacement should be made before the surface is applied. Under a CWA project we had a survey made of the drainage structures under our county roads. We found that on the 717 miles of county highways we had about 3,400 structures. This includes all openings under the highways from 4 in. pipes to 3-span bridges. Many of the older pipes are of vitrified clay and have been badly cracked by the modern heavy loads.

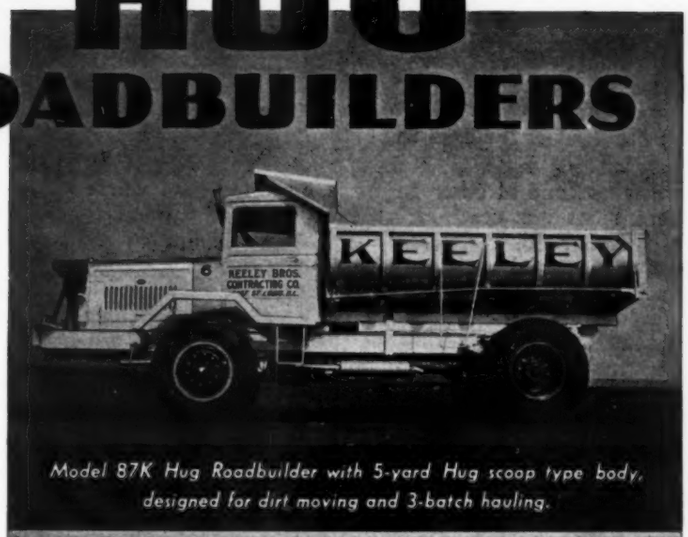
It is only a question of time until all of these must be replaced. This replacement will necessitate the digging of a trench across any road surface which may be on the road at that time. It is very difficult to fill this trench so that there will not be a rough spot in the road surface for some time after the pipe has been installed and the trench refilled. Many of our larger bridges should be replaced with stronger structures in the near future. This will require changes in the road surface on the approaches. We feel that a road is no better than its poorest sections and that a rough spot caused by the replacement of a structure largely offsets any advantages that may be gained by its resurfacing. The inlets and outlets of drainage structures should be given attention. In many instances the cleaning away of rubbish from the inlet and the deepening of the outlet will cause a pipe culvert to carry all the water which normally flows to it with no damage to the road surface while if the same pipe is neglected serious damage will result.

Present Subgrade and Surface—The present condition of the road surface will largely determine the kind and quantity of resurfacing to be added. As we have a great many gravel pits in Wayne County, it is the common opinion that all a road needs when it becomes rough is to have some gravel added to its surface. The greater part of our roads are located on the section lines, consequently we have a cornerstone in the middle of the road each half mile. I say "have," but should say "had," for it was the practice for some years to remove these stones whenever they interfered with any road equipment. During the past five years we have adopted a different plan. Whenever one of these stones interferes with any construction or maintenance work which is being done on the road it is reported to our office. We then send one man from the surveyor's office and a light truck and driver from the highway department and lower the stone if it is too high or set an iron pin on top of it if the road is to be raised. The method used is to first set four reference stakes from the stone in its original position. If the stone is too high, enough gravel and dirt is removed from around the stone so that it can be pulled out with the truck. A hole is then dug and the stone placed deep enough to prevent any interference with road work, using the reference stakes to replace the markings in exactly the same position as before. If a fill is to be made so that it will be difficult to get at the original stone references, stones are placed as described above and when the fill is completed an iron pin or pipe is driven directly over the mark on the corner stone.

In laying the concrete and brick pavements some years ago, no attention was given to these corner stones. This causes a lot of extra work on land surveys in these locations. In recent years all corner stones have been carefully referenced before any pavement of a permanent nature was laid and permanent marks made in the pavement when completed. In pavements laid by the state we have co-operated with the state highway engineers in having these marks set. In the past five years we have lowered nearly 100 corner stones as described above.

In doing this work we noted the depth of the gravel and were somewhat surprised to find that in nearly all instances the gravel was 8 ins. or more in thickness. As these stones were always near the center of the graveled part of the road, we decided to dig some test holes on each side of the center line to determine whether this thickness was the same for the entire width of the road. About this time the road department decided to resurface 1¾ miles of gravel road by adding a bituminous course of rock asphalt wearing course. It was decided to dig test holes in this road to determine the exact thickness of the gravel surface then on the road. Accordingly holes were dug through the gravel on the center line of the road and at points 5 and 10 ft. each side of the center line. Along the center line these holes were about 100 ft. apart, with closer spacing where there were any indications that there might be a change in conditions. It was found that on the center line and at the points 5 ft. on each side of the center line the gravel was from 8 to 10 in. thick. At the points 10 ft. on each side of the center line the thickness of the gravel averaged about 4 in. We decided that this was due to the widening of the gravel to fit modern traffic conditions after it had been dumped in the middle of the road. By digging

3 Pace-Setting HUG ROADBUILDERS



Model 87K Hug Roadbuilder with 5-yard Hug scoop type body, designed for dirt moving and 3-batch hauling.

Model 97L Hug Roadbuilder with 8-yard Hug rock type body, for dirt and quarry operations.

Model 87Q Hug Roadbuilder equipped with 6-yard Hug scoop type body and especially designed for dirt and rock moving.

● Whether your hauling requirements call for batch hauling, dirt moving, or quarry operations, there is a Hug Roadbuilder built to meet your particular requirements.

The Model 87K for batch hauling

The Model 97L for dirt and quarry operations

The Model 87Q for dirt and rock moving

These Hug models are typical of the complete line of Hug Roadbuilders embodying outstanding features of design and construction that have made the Hug Roadbuilder famous for construction projects throughout the entire country.

Here are some reasons why Hug Roadbuilders can set a pace no other truck can meet: The Hug set-back wheel design with resulting short turning radius; the Hug front axle rocker action that eliminates thrusts and strains; the Hug multi-cushion rear spring designed especially for the Hug Roadbuilder; the Hug back-up brake which makes the long back-up easy, and the Hug electric arc welded "I" beam frame.

Other features that add to the Hug performance record are: the Buda heavy duty six-cylinder truck engine; the double reduction full floating rear axle with high traction differential; helical gear transmission with wide variation of speeds; cam and lever steering and special Hug-designed body equipment.

THE HUG COMPANY

574 Cypress Street
Highland, Illinois

HUG

BUILT TO MEET A CONDITION

a few trenches entirely across the road it was found that a strip in the middle of the road about 12 ft. in width was graveled with the greater depth of gravel mentioned above and the remaining 4 ft. on each side was only graveled to the lesser depth. By inquiry from the residents along the road we found that the road was sometimes cut through during the spring thaws and by investigating the points where we were told that the road did cut through we found that the defect was one of drainage rather than depth of gravel. Observations on other roads during spring thaws have led us to believe that stability is not so much a question of thickness of gravel but rather a question of the proper placing of the gravel after the road has been properly drained.

By digging some test holes in roads which were badly corrugated and at other points in the same road where the surface was comparatively smooth we were led to believe that this corrugation is quite often due to the oversize material in the gravel. Where properly graded gravel is added in thin layers over these corrugations it does not seem to help much. In fact we think that this new material is practically wasted when applied to any road that has not been thoroughly smoothed and brought to uniform texture and proper cross section before the new material is applied. Where this oversize material exists we think that it would pay to scarify the road to a depth of 6 in. and then remove the oversize by hand raking if necessary. If this material could be crushed and placed back on the road without too much expense this would be a fine way to dispose of it. If this is not possible we think we would be justified in wasting it on the widening of narrow fills.

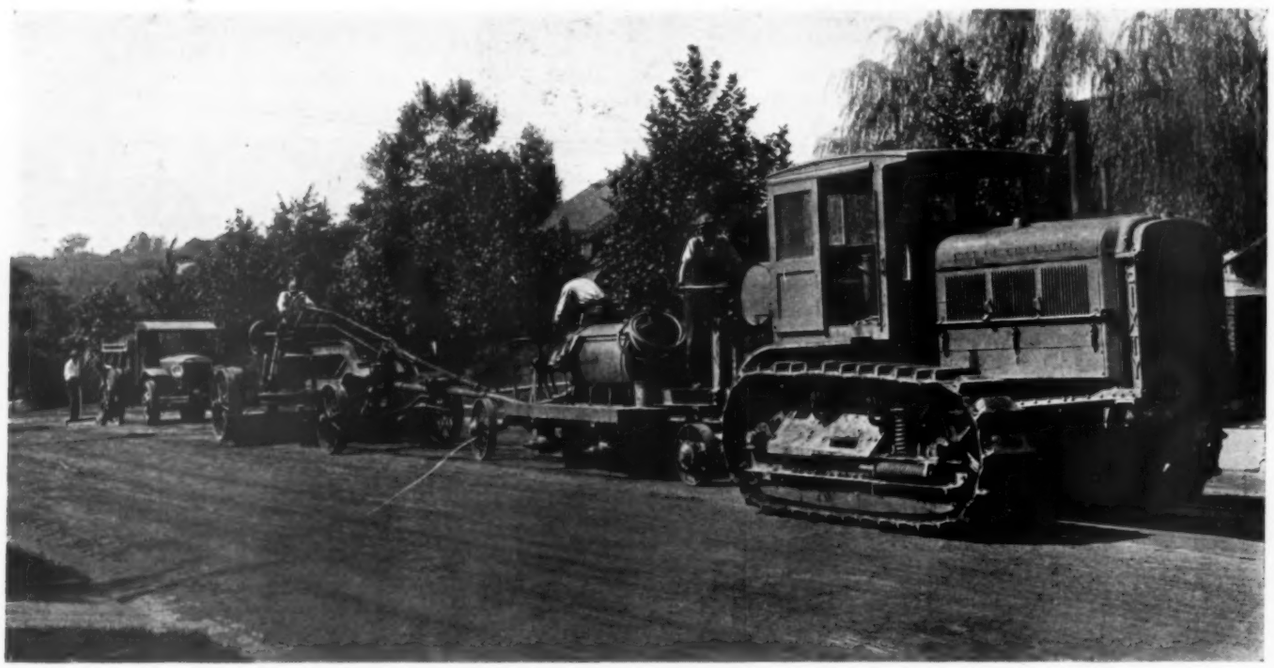
In applying gravel during the winter provision should be made for spreading the gravel each evening. If the gravel becomes frozen before it is brought to proper cross section it is very difficult ever to get it in shape and a large part of the benefit of the new material is lost as it is much easier to prevent a road from becoming rough than it is to make it smooth again after it has become rough.

Our entire resurfacing work could be much more efficiently and economically done if a definite program for a period of years could be adopted and made a matter of record and then carried out by whoever might be in charge of road work. Under our present system one person maps out a program and gets certain roads in shape for resurfacing the following year. The following year some other person is appointed to take charge of the road maintenance and does not resurface the roads already selected but starts on another list of roads. The net result is a loss to the taxpayer.

In conclusion we would like to emphasize these points on resurfacing:

1. Keep within your budget. You do not get much of a thrill out of paying back bills, either of your own or someone else.
2. Spend all the time you can in riding over the roads so that you may know what roads need resurfacing the most.
3. Select the materials for resurfacing that will make maintenance easier and cheaper.
4. Don't resurface until you are sure that the drainage has been well taken care of.
5. Don't resurface until the old road surface has been properly prepared to receive the new material.
6. Don't expect that the new surface will not require maintenance.

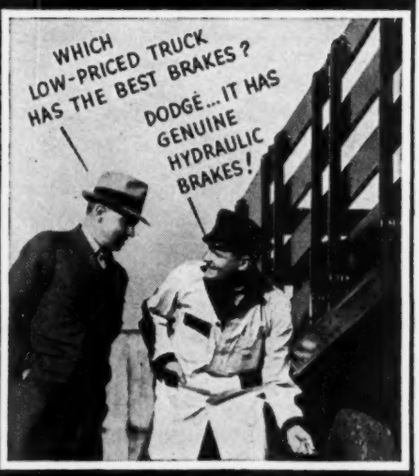
The foregoing is a paper presented at the 22nd Annual Purdue Road School.



Road Planing Operations by the City of Cincinnati, O.

The Bureau of Highways of the city of Cincinnati takes care of the troublesome washboard corrugations which sometimes develop on macadam streets by planing off all high spots with a disc planer pulled by a tractor. The scraper following fills in all depressions and accumulates the excess material which is removed by the truck in the rear. This operation is usually followed by an application of a bituminous seal coat.

BUY YOUR TRUCK THIS WAY...



AND YOU'LL SAVE BIG MONEY

FREE GAS TEST
Clever invention shows how far any truck will go on a gallon of gas. Ask your Dodge dealer to use it FREE!
HEINKE BROS.

COMPARE! Get the facts! Learn for yourself which truck of the lowest-priced three really gives you the most *quality*. That's the smart way to pick a truck if you want it to save money and last a long time.

One good way to get the facts is to ask Dodge owners. Let them tell you how "New Dodge trucks are saving up to $95 a year in gas alone ... with other surprising big savings on oil, tires and upkeep."

Get a "Show-Down" Score Card

Dodge dealers now offer FREE a little "score card" that shows you another easy way to judge truck quality in the lowest-priced field. Sit down with it for five minutes and you can learn more about all the lowest-priced trucks than you could find out in hours any other way. It shows you exactly what features Dodge has, and exactly what all the others have.

Before you buy any truck, compare Dodge. Make the FREE gas mileage test. Get a "Show-Down" Score Card. Phone or visit your Dodge dealer today!

DODGE
Division of Chrysler Corporation

NEW DODGE 1½-TON, 6-CYL., 136' W. B. STAKE... Has full-floating rear axle, genuine hydraulic brakes, valve seat inserts, roller-bearing universals, 4 piston rings instead of only 3, and many other extra-quality features..... **$690***

NEW DODGE COMMERCIAL EXPRESS—116' W. B.—6-cyl.—Fast, easy to handle, dependable. Built to do a lot of work in a day! Has all the famous Dodge quality features to save gas, oil, tires, upkeep..... **$500***

* * *

**List prices at factory, Detroit, subject to change without notice. Special equipment, including dual wheels on 1½-ton, extra. Easy terms gladly arranged to fit your budget, at low cost, through Commercial Credit Company.*

$370* ½-TON CHASSIS 116" W.B.

Dependable **DODGE TRUCKS**

A HALF BILLION DOLLAR ROAD PROGRAM FOR NEW YORK STATE

FIVE hundred and three million, five hundred thousand dollars to be expended over a period of approximately 8 years is recommended in the Fearon Legislative Highway Survey Committee's report filed with the New York State Legislature on March 13.

The following outline of these proposed expenditures and the revenues from which they are to be paid is condensed from the report.

IT SHOULD be borne in mind that the program if adopted, would do nothing more than to complete our highway system as presently planned. It has been the opinion of the Committee that before any great expansion of the highway system is undertaken to meet the increasing demands of motor vehicle transportation, the system as now laid out on the State and county highway maps should be completed, and the town roads should be improved.

If and when that program is completed the State will still face a highway problem—a problem not only of reconstructing those roads which in the meantime will have deteriorated but also of altering and expanding the system to meet traffic requirements. The problem will require continuous study and continuous expenditure of public funds. This program simply outlines what should be done at once or as rapidly as the financial ability of the State will permit.

The first thing to be done is to complete the State highway system proper, which comprises our main arteries, and the Committee is making recommendations for annual appropriations to accomplish this.

If the county system could be completed and roads adequately posted, traffic congestion would be greatly relieved and the accident hazard reduced on the main highways. Furthermore, some of the roads on the county system have gained an importance equal to if not greater than some of the roads on the State system. It is therefore of the utmost importance that construction of the county system be expedited and the Committee is therefore recommending increased State aid to counties. Likewise the Committee is recommending increased State aid to towns for the improvement of town roads as outlined in another chapter of this report.

TABLE NO. 1.

Estimated Cost of Constructing and Rehabilitating the Various Highway Systems in the State

(a) State Highway Reconstruction Program (5 years)	$138,000,000
(b) Construction to complete the State system and including parkway construction outside of cities (8 years)	80,000,000
(c) Arterial city streets and by-passes outside of New York City (5 years)	35,000,000
*(d) Construction to complete County Road system and reconstruction	124,000,000
*(e) Construction to complete Town Highway system	66,500,000
*(f) Arterial Highway system requested by New York City	60,000,000
Total	$503,500,000

*Time within which system will be completed not shown.

Under the heading Arterial and By-pass Highways the Committee has made specific recommendations for aid to cities. The Committee is of the opinion that the cost of constructing streets which carry traffic through cities should not be assessed against local real estate but should come out of the fuel tax and motor registration fees and should be a State charge. Similarly it believes that real estate should not pay the entire cost of paving and maintaining city streets which are not arterial highways and it is consequently recommending direct aid to cities by the State out of the fuel tax and motor registration fee moneys.

Explanation of Expenditures

Item (a) of Table No. 1 is explained as follows:

This contemplates during a five-year period the reconstruction of a certain mileage on the State System which in its present condition does not meet the requirements of traffic. It is a recurring item of expense which must always be considered in any comprehensive highway program to provide for rebuilding highways which have worn out or need improvement to adequately meet the demands of traffic. The estimate includes the reconstruction of 1,615 miles of highway and contemplates new pavement of a suitable type, depth and width, improved alignment, better grades, longer sight distances and improved drainage, all to the extent deemed necessary to provide a highway that will properly meet the requirements of traffic. The estimate also includes the resurfacing or retreading on 1,765 miles of highway. This does not contemplate major changes in alignment or width but rather the placing of a new top or wearing surface on the existing pavement. The estimate further includes a widening of the pavement on 1,850 miles of highway from two to four feet. This is simply providing for increased width on this mileage which otherwise is in satisfactory condition. The total cost of performing the work as above outlined on the 5,230 miles of highway is.....$113,500,000

Construction and reconstruction of bridges are estimated at..... 15,000,000

Cost of securing necessary rights of way is estimated at..... 9,500,000

Total, Item (a).....$138,000,000

Item (b) includes completion of 1,101 miles of unimproved highways on the official State Highway Map.....$ 48,000,000

Parkway construction outside of cities, including rights of way..... 32,000,000

Total, Item (b).....$ 80,000,000

Item (d), construction and reconstruction of County Road System, involves to a very great extent the same conditions which control the reconstruction of the State Highway System.

Estimated cost of improving 4,520 miles of unimproved roads of the present county system .....$ 67,000,000

Dividing the streams of traffic and paving with concrete, as illustrated by U. S. 41 south of Milwaukee, Wis., are real aids to highway safety.

WHY THIS STEADY PREFERENCE FOR CONCRETE ?

Why does concrete continue, year after year, to be the preferred highway pavement? The answer is as simple as A-B-C:

A—Concrete is satisfying. Motorists appreciate the smooth, restful ride it affords; the absence of ruts, jolts and wheel-strain with consequent freedom from tension and fatigue.

B—Concrete is safe. Its surface is smooth but non-skid, wet or dry; it reduces the frequency of accidents; and its light grey color with sharply defined edges gives maximum visibility at night.

C—Concrete is economical. It actually costs less to build than any other pavement of equal load-bearing capacity; it lasts longer; its maintenance cost is far less and it saves money for motorists by reducing gas, tire and car repair expense.

Write us for any or all of the volumes in the Concrete Pavement Library—*Concrete Road Design Simplified and Correlated with Traffic; Short Count Traffic Surveys; What Old Concrete Roads Tell Us; Concrete Pavement Manual.*

PORTLAND CEMENT ASSOCIATION, A5-28, 33 W. Grand Ave., Chicago, Ill.

Yes—We would like you to mention ROADS AND STREETS

Reconstruction work on 6,540 miles of improved roads on the system.....	57,000,000
Total, Item (d).....	$124,000,000
Item (e). The estimate provides for improving 2,892 miles of Town Highways to the standard designated "Class II," and 22,026 miles to the standard designated "Class III." Total estimated cost of the 24,918 miles of improvement is....	$ 66,500,000

Annual Program

It is now the purpose of the Committee to recommend an average annual highway program. To finance such a program it recommends a permanent fuel tax of three cents per gallon and continuance of the present registration fees on motor vehicles with all the receipts from such tax and fees being used only for highway purposes.

TABLE NO. 2

Recommended Yearly Highway Program on Basis of Three-Cent Fuel Tax and Present Registration Fees All Being Used for Highway Purposes

Revenues—		
Fuel and Registration Tax.....		$88,000,000
Regular Federal Aid.....		6,150,000
Total		$94,150,000
Expenditures—		
State:		
Maintenance	$ 9,000,000	
Reconstruction State System including bridges and right of way (5-year plan)	27,500,000	
Sanding and Snow Removal.....	1,500,000	
Construction State System including Parkways outside of cities (8-year plan)....	10,000,000	
		$48,000,000
County:		
State Aid	$ 2,000,000	
Refund registration fees and fuel tax.....	12,000,000	
(A) Reconstruction County Road System	3,000,000	
		17,000,000
Towns:		
State Aid	$ 3,000,000	
(A) Construction and reconstruction of Town Roads by the County.....	4,000,000	
		7,000,000
Cities outside New York:		
(A) Construction and reconstruction of arterial and by-pass highways by the State (5-year plan).....	$ 7,000,000	
(A) State Aid	3,000,000	
		10,000,000
New York City:		
Refund registration fees and fuel tax....	$ 6,000,000	
(A) Construction and reconstruction of arterial highways and by-passes.....	4,000,000	
		10,000,000
		$92,000,000

Items marked (A) totaling $21,000,000 are new disbursements to Governmental units.

Explanation of Revenues

From a study of the registration figures of motor vehicles in this State during the past five years and the receipt from registration and other fees and from the fuel tax it is estimated that with a three-cent fuel tax and a continuance of registration fees on motor vehicles in their present amounts that the total receipts from such sources for the average year during the next five-year period will amount to $90,000,000. The present cost of collecting these fees and taxes is about $1,600,000 per year. Assume such cost to be $2,000,000 for the average year during the next five-year period. This will leave a net annual amount of $88,000,000 as the revenue from registration fees and the fuel tax.

It may reasonably be expected that $6,150,000 will be available annually in the form of regular Federal Aid. This is in addition to the emergency grants received during the past few years and applicable to highway.

▼

Activities of Construction, America's Key Industry Summarized

Recent developments in construction, America's "key" industry in present national employment problems, are presented in a survey, "The Construction Industry," made public April 27 by the Commerce Department. The report combines an analytical discussion of the construction industry with a practical handbook or guide to the industry as represented by its leading trade associations. It was found that approximately 600 trade associations of national or interstate scope are now organized in the building and allied industries; the name and address of each is given.

The study presents a co-ordinated picture of all construction activities in the United States, and a running summary of trends in recent years for the various fields of construction, including commercial, industrial and residential buildings, road construction, and the programs of governmental and public utility agencies. It also contains a summary of 1935-1936 projects and plans of the Federal Government in power and irrigation dam construction.

Estimates from both private and public sources are included. They show that this industry, averaging over 12 billion dollars annually during the 1926-1928 period, fell to less than one-third of that amount in 1933. Data are presented showing the increases since then, into early 1936. Estimates are included on the volume of construction in 17 fields. Statistics with textual comments cover the manufacturing, wholesaling and retailing of building materials, and the number of employees in job-site construction.

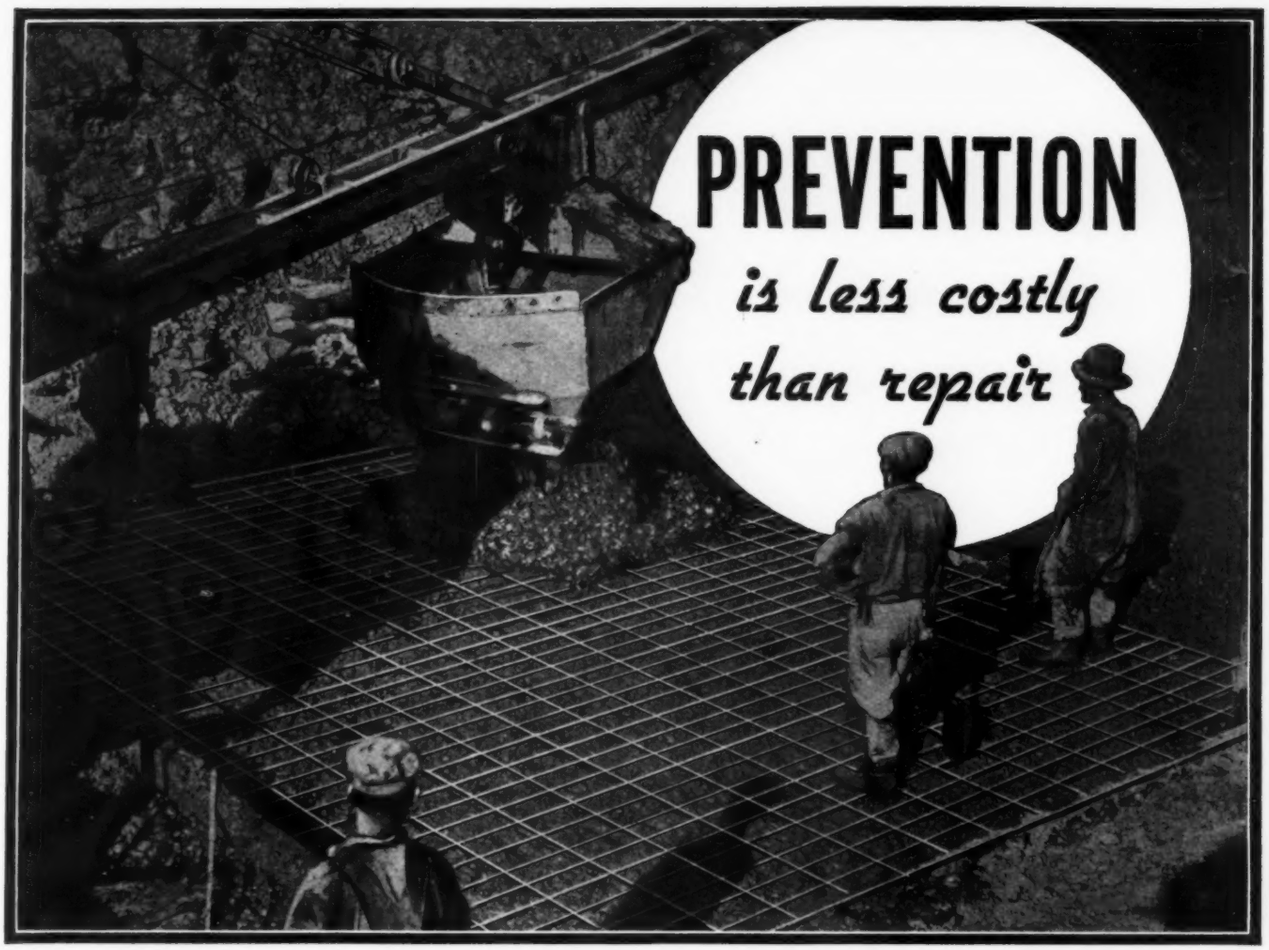
Journals in construction or allied lines and many private research bureaus are listed, with addresses. A brief summary is given of each of the agencies of the Federal Government now assisting in the rehabilitation of the construction industry.

This study of 123 pages, including 37 pages of charts, maps and tables, may be obtained for 10 cents from the Bureau of Foreign and Domestic Commerce in Washington, D. C., or any of its district offices in larger cities throughout the United States.

▼

New Jersey's Works Program Grade Crossing Projects—1936

Allotments for 33 works program grade crossing projects in New Jersey had been made up to the end of March, 1936, the total estimated cost being $3,996,469, or an average of $121,000 each. The smallest of these jobs is estimated at $8,325—the largest at $375,714. Materials for the 33 crossings are estimated at $1,658,111, or 41% of the total cost. Direct labor is estimated at 2,386,607 man hours, costing $1,602,688, or about 67 cents per hour average. The daily average number of men is estimated at 2,622.



The use of Pittsburgh (National) Reinforcing in the construction of concrete pavements is a measure of prevention that will eventually save heavy repair bills and costly replacement. Pittsburgh Reinforcing, a welded mesh fabric, prevents progressive disintegration by holding incipient cracks tightly closed. Inert material is excluded, the formation of ice minimized, and small cracks thus prevented from becoming serious breaks.

Pittsburgh (National) Reinforcing is a complete unit of reinforcing composed of rigidly fixed members of comparatively small diameter, closely, accurately and permanently spaced at the mill. Obviously a mesh of this kind is more effective than reinforcement composed of larger members spaced further apart. For a more complete discussion of Pittsburgh Reinforcing and its use in Crack Control, send in the coupon.

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SOURCES OF REVENUE FOR NEW HAMPSHIRE HIGHWAYS

A financial survey having for its primary purpose the determination of all facts conected with the financing of roads in the State of New Hampshire was made during 1934 under a co-operative agreement between the Bureau of Public Roads and the University of Wisconsin. The study was made under the immediate direction of Dr. Henry R. Trumbower, Professor of Economics at the University of Wisconsin and economist of the Bureau of Public Roads, and H. R. Briggs, field investigator and statistician. The data for the survey were for the calendar year 1932. A digest of the survey with special reference to highways is given in the April issue of Public Roads by Elizabeth Church, Assistant Research Analyst, Division of Highway Transport, U. S. Bureau of Public Roads. The following summary is taken from the digest:

1. Only 4.7 per cent of the funds expended on State and State-aid roads was raised from taxes on property.

2. Rural property owners paid no tax for urban streets.

3. Of the total tax on rural property expended for highway purposes—

(*a*) 19.9 per cent was expended on State and State-aid roads.

(*b*) 80.1 per cent was expended on local rural roads.

4. Of the total tax on urban property expended for highway and street purposes—

(*a*) 3.5 per cent was expended on State and State-aid roads.

(*b*) 96.5 per cent was expended on urban streets.

5. Since, of the total assessed property valuation of $623,381,700, 29.4 per cent, or $183,277,500, was in rural areas, and 70.6 per cent, or $440,104,200, was in urban areas—

(*a*) Expenditures from property taxes for all highways and streets were at the following rates per $100 of assessed valuation:

Rural—66.7 cents.
Urban—29.5 cents.

(*b*) Expenditures from property taxes for State and State-aid roads were at the following rates per $100 of assessed valuation:

Rural—13.3 cents.
Urban—1 cent.

(*c*) Expenditures from property taxes for local town roads were at the following rates per $100 of assessed valuation:

Rural—53.4 cents.
Urban—No tax.

(*d*) Expenditures from property taxes for urban streets were at the following rates per $100 of assessed valuation:

Rural—No tax.
Urban—28.5 cents.

6. Of the total property taxes expended on all roads and streets—

(*a*) 11.5 per cent was expended on State and State-aid roads.

(*b*) 38.8 per cent was expended on local town roads.

(*c*) 49.7 per cent was expended on urban streets.

7. Of the total motor-vehicle imposts expended on all classes of roads and streets—

(*a*) Motor-vehicle owners in rural areas paid 21.5 per cent, and these same rural owners performed 23.8 per cent of the total travel on all classes of roads and streets.

(*b*) Urban motor-vehicle owners paid 78.5 per cent, and performed 76.2 per cent of the total travel.

8. Of the total motor-vehicle imposts (including nonresident fees) expended on all classes of roads and streets—

(*a*) 96.1 per cent was expended on State and State-aid roads.

(*b*) 3.9 per cent was expended on local town roads.

COMPARISON OF TAXATION AND EXPENDITURES IN 1932

COMPOSITION OF EACH $1,000 OF TAXES

Type of tax	Collected from residents of—	Amount	Percentage of total in each group
General property taxes	Rural areas	$ 158.06	26.2
	Places to 2,499	97.13	16.1
	Places 2,500 to 14,999	140.57	23.3
	Places 15,000 to 74,999	107.99	17.9
	Manchester	99.54	16.5
	Total	$ 603.29	100.0
Motor-vehicle taxes	Rural areas	$ 41.83	21.5
	Places to 2,499	37.74	19.4
	Places 2,500 to 14,999	45.33	23.3
	Places 15,000 to 74,999	25.68	13.2
	Manchester	25.87	13.3
	Nonresidents	18.09	9.3
	Total	$ 194.54	100.0
Miscellaneous taxes	Rural areas	$ 50.14	24.8
	Places to 2,499	33.56	16.6
	Places 2,500 to 14,999	52.16	25.8
	Places 15,000 to 74,999	32.95	16.3
	Manchester	33.36	16.5
	Total	$ 202.17	100.0
	Grand total	$1,000.00	....

COMPOSITION OF EACH $1,000 OF EXPENDITURES

Expended for—	Source of funds expended	Amount	Percentage of total in each group
Highways on State system	Rural areas	$ 38.39	17.6
	Urban areas	95.61	43.8
	Nonresidents	15.39	7.0
	Federal aid	13.11	6.0
	Loans and reserves	55.91	25.6
	Total	$ 218.41	100.0
Local town roads	Rural areas	$ 23.80	47.6
	Urban areas	22.05	44.1
	Loans and reserves	4.15	8.3
	Total	$ 50.00	100.0
Urban streets	Urban areas	54.20	100.0
	Total all highways and streets	$ 322.61	....
Education		269.44	....
Public benefit		348.68	....
Government		59.27	....
	Grand total	$1,000.00	....

9. Of all imposts and taxes (including Federal aid and loans and reserves) expended on all roads and streets—

(*a*) 67.7 per cent was expended on State and State-aid roads.

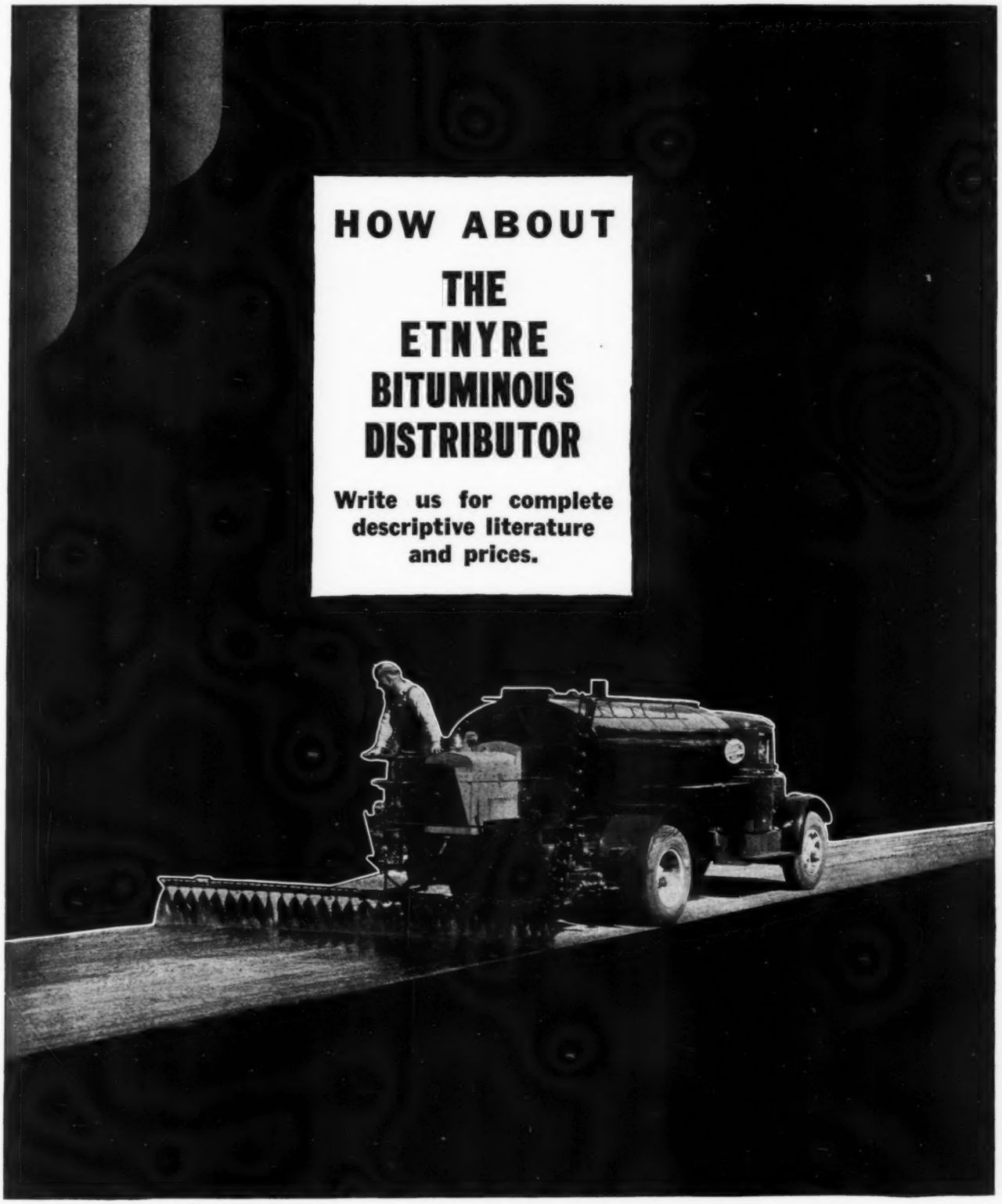
(*b*) 15.5 per cent was expended on local town roads.

(*c*) 16.8 per cent was expended on urban streets.

10. Of all current imposts and taxes paid by residents, expended on all roads and streets—

(*a*) Rural property and motor-vehicle owners paid 34.1 per cent, and travel by rural vehicles made up 23.8 per cent of the total travel on all classes of roads and streets.

(*b*) Urban property and motor-vehicle owners paid 65.9 per cent, and travel by urban vehicles made up 76.2 per cent of the total travel.



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ROADS AND DRIVES IN CONSERVATION PROPERTIES

By DENZIL DOGGETT,
Assistant State Engineer,
Indiana Conservation Department, Indianapolis

INDIANA'S Conservation Department is entrusted with the operation and maintenance of 68,000 acres of the state's holdings in state parks, forests, game preserves and fish hatcheries. Last year a paid attendance of 770,000 persons visited state parks, with an estimated total of more than a million and a quarter visiting the Conservation properties.

Roads and drives in Conservation land areas are not the same high types of highways as those in the state system. They are designed for less speed and for passenger vehicles rather than the heavier type of freight carriers common on all our state and federal highways.

Road Layout Fitted to Ground Forms—In state parks the principal drives are fitted to the ground forms encountered in the layout of the road. A real effort is made to keep from making deep cuts and fills—it is bent toward making a scenic drive rather than a high speed roadway. As a matter of fact, a strenuous effort is made to limit the speed of all vehicles to 25 miles per hour or less.

In laying out park drives, this maximum speed of 25 miles per hour is used in figuring super-elevation of curves. Vertical curves are designed to give the driver visibility at all times. The drive is laid out with easy curves and an effort is made to avoid compounding curves. This makes for easier driving and aids in handling traffic. Much of our park traffic is composed of cars driven by the comparatively inexperienced driver who has only an occasional Sunday for an outing.

In the construction and maintenance of these park drives, guards rails are installed to protect the motorist in the event he is careless or his car becomes unmanageable.

Park Roads Have Definite Purpose—All roads in parks have a definite purpose even though they may seem rather sinuous and meandering to those used to the design, construction and maintenance of high speed highways. This purpose is the leading of the visitor from the park entrance to the major scenic points of interest, the service area, picnic and camp grounds, and concession areas. By concession is meant the lunch and soft drink stands and hotels such as are located in most of our parks. Roads which serve as service roads to water supplies, sewage disposal plants, wood yards, gravel plants, quarries, etc., are not stressed and are usually closed to public use. They are usually not laid out with the same degree of refinement nor constructed with the safety features found on the main drives.

The Forest Roads—In state forests, the principal road connects the nearest state or county highway with the service area and usually passes or leads to a picnic ground provided for public use. In the operation of the state forest, the primary considerations are the silvicultural work, namely, the cultivation of the hardwood and other useful timber trees, the elimination of weed species, the logging and sawing of these weed trees and those of stunted growth, and the fire protection programs. This latter work extends into the neighboring, privately-owned timber land and necessitates fire trails which connect with outside county roads as well as cover the state-owned areas. Picnic areas are incidental in state forests. They are supplied with potable water, furnaces, tables, and shelters and are connected with the main drive. They are furnished as a convenience to those desiring to view the plantings and forest improvement work which is carried on in each state forest as a demonstration of the methods that should be used by the private land-owners in their woodlots or classified forest areas.

In game preserves, the principal road connects the nearest arterial highway with the service area of the preserve. This service area is the center of all operations and displays in the preserve and includes wild game and animal exhibits, bird exhibits, rearing and holding pens for pheasants, quail, rabbits and raccoons, water fowl displays, etc.

Fish hatcheries, being very compact in arrangement, have a drive connecting their service buildings with the nearest county or state highway. In some cases a service road connects the pond areas of the hatcheries as an aid to servicing the ponds through the hatching, rearing and fingerling distribution periods.

In the construction of park drives and roads, forest roads and fire trails, game preserve roads and fish hatchery drives, local materials are used if they are suitable. Specifications of the State Highway Commission of Indiana are used in all purchases of aggregates and in the production of materials from the Conservation Department's gravel plants and stone crushers.

Grades are Kept to a Minimum—In planning drives in State Parks, every effort is made to keep the grades to a minimum. In most cases this is possible. At Clifty Falls State Park, however, it was found necessary to use a 12 per cent grade for a short distance on the new entrance road from State Road 56, near Madison. The average grade on this 4,400-ft. length of road is 10 per cent. This grade, however, is unusual as it is usually possible to keep below an 8 per cent grade on most of the park drives. Due to limited working space, it is not always possible to keep the degree of curvature within limits considered best in state and county highway work. Usually limits of curvature are kept low enough that the roads are not dangerous at a speed limit of 20 to 25 miles per hour.

In the construction of park drives, specifications are prepared that will give a road heavy enough to carry a great number of passenger automobiles and a few light trucks and busses. The use of loaded E. C. W. trucks on the park drives has overloaded those constructed previous to the C. C. C. movement and caused an undue

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amount of maintenance. In construction which has been prosecuted since the advent of the Civilian Conservation Corps, heavier bases are being constructed on all drives and roads located in all properties.

The Surfacing Varies—The surfacing of each road varies with the materials available on the property involved. For instance, at Brown County State Park, Clifty Falls State Park, Morgan-Monroe State Forest and Spring Mill State Park, where crushed stone is available and traffic warrants the expense, an oil-mat mulch surface has been applied to the macadam road already there. New drives at these places are constructed expressly for this oil mat type of surfacing. At other properties an oil-mat mulch has been built up on a gravel base. Stabilized surfaces have been tried in the past few years, using gravel and clay as aggregates, and have been found satisfactory. Due to the rounded nature of the dune sand at Indiana Dunes State Park, it was found necessary to make all roads and parking areas of concrete slab. This is the only conservation property in which concrete construction was necessary. Every effort is made to keep the number of types of surfacing as low as possible in order to simplify the maintenance problem.

Maintenance of the oil mat type of surface is handled through cooperation with the State Highway Commission of Indiana. This organization advertises and contracts the application of tar or asphalt and chips and is reimbursed for this work together with payment for labor, equipment and supervision for the manipulation required.

Bridges and Culverts—Cross drainage is usually handled by culverts without head walls, merely adding planting of shrubs and vines to hide the exposed metal. During the past two or three years of Emergency Conservation Work there has been a tendency to add low head walls of stone native to the park or forest in which the road is being constructed.

On locations where the cross drainage requires a greater cross sectional area than is available in pipes, combination metal and stone arches, stone arches or small concrete bridges, all with stone or wood headwalls and railings suited to the property involved, are used extensively. Most of these structures give a well balanced and pleasing appearance that goes well with park and forest types of construction.

Where stone headwalls are used, the random asthlar type of stone work is used. Different types of stone are used, giving a variety to each property which is pleasing to the visitor. This is felt to be important in this phase of the department's construction work, as pleasing impressions cause visitors to advertise the property to their neighbors, thereby increasing attendance.

Timber Trestles Used—In larger structures where the span must be great in order to cut down excessive fills, rough sawed timber trestles are used. Two have been constructed in the past three years by the Civilian Conservation Corps. One, having a span of 176 ft. and maximum height of 65 ft., is constructed of rough sawed white oak timbers and carries a concrete road deck 22 ft. in width. It is located on the new entrance road at Clifty Falls State Park. A rough hewed wooden hand rail completes this structure. The other is a structure of the same sort which is 160 ft. long, uniformly 10 ft. high and carries a 22 ft. concrete roadway with two cantilever sidewalks, 5 ft. wide, and is located at Indiana Dunes State Park. It carries a concrete camp ground over an arm of a swamp which is subject to floods.

Stone Arch Bridge—Another larger structure which is somewhat unusual is a 54 ft. Oolitic limestone arch bridge, carrying a stabilized gravel road 22 ft. wide with a 5 ft. sidewalk on one side. This bridge spans McCormick's Creek a few hundred feet above the falls and carries the picnic ground road from the hotel to the Beech Grove area. This structure is located at McCormick's Creek State Park and was built by the C. C. C. camp which was located there for a two-year period.

The foregoing is an abstract of a paper presented at the 22nd Annual Purdue Road School.

▼

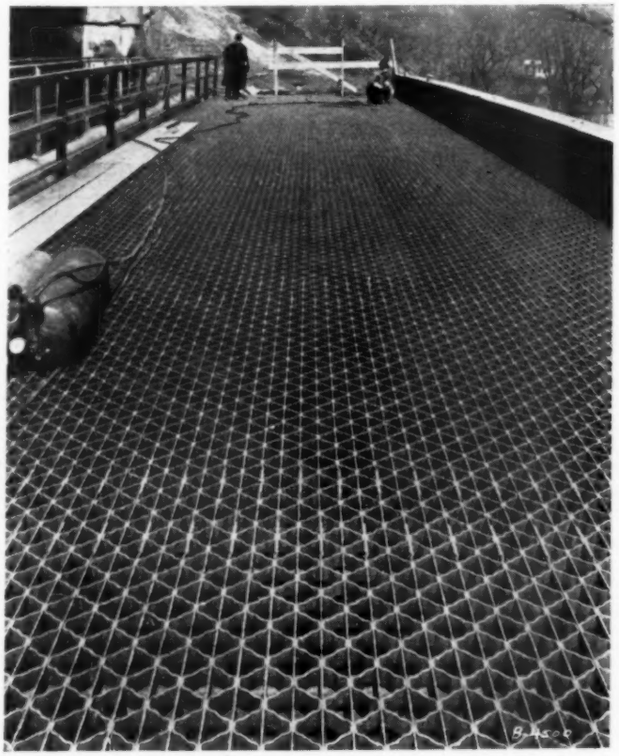
Steel Flooring Used on Short Span Bridge

When the recent Pittsburgh flood floated away the wooden deck of the bridge over Nine Mile run the residents beyond were isolated and without access by fire apparatus or other motor transport until such time as the span could be put back into service.

Speed of repair was highly essential but it was also necessary that the repair be permanent and adequate to take care of whatever traffic the original girders could accommodate. The problem was solved very satisfactorily by the use of Blaw-Knox-Irving bridge floor which effected the permanent repair in three weeks and also greatly increased the capacity and safety of the bridge.

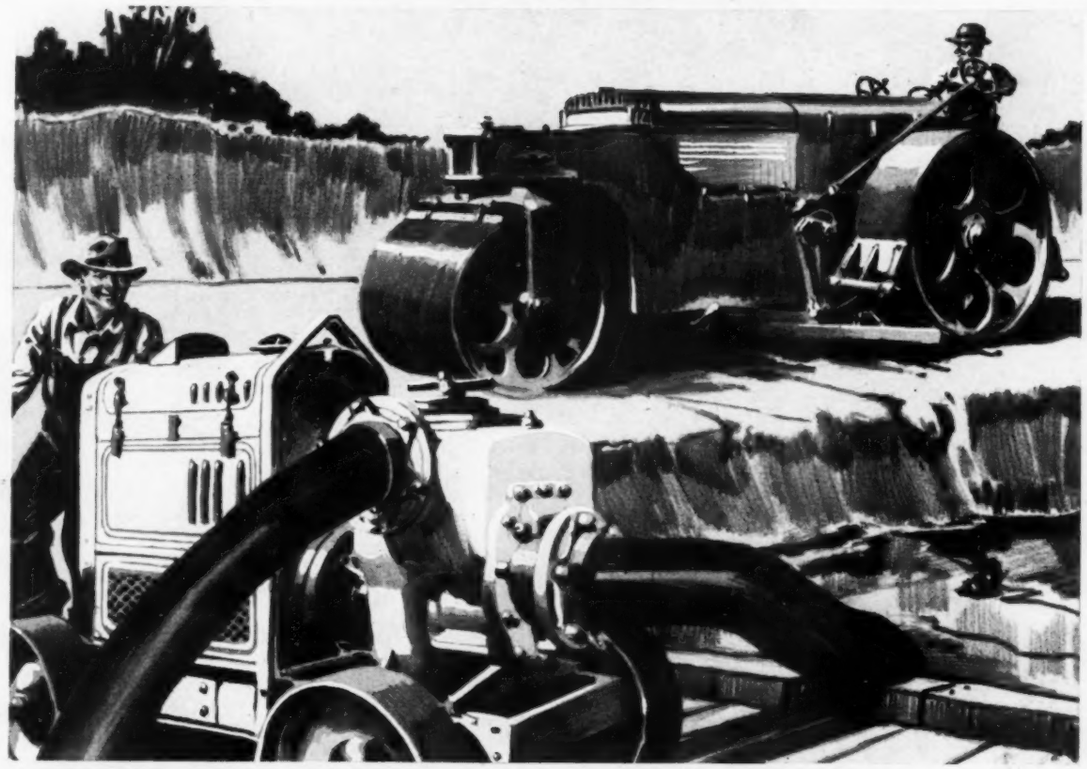
The subject of light weight bridge floors is not a new one but it has been approached, heretofore, from the economics of first cost, and therefore, limited to long spans. The present case is an example of the highly justified use of steel flooring of light weight for short spans.

The accompanying illustration shows the new floor nearing completion. It gives a close view of the detail of the main and secondary members and illustrates very clearly the method of splicing the sections together to make the main members continuous from end to end of the span.



Installation of Steel Flooring on Nine Mile Run Bridge

HERCULES



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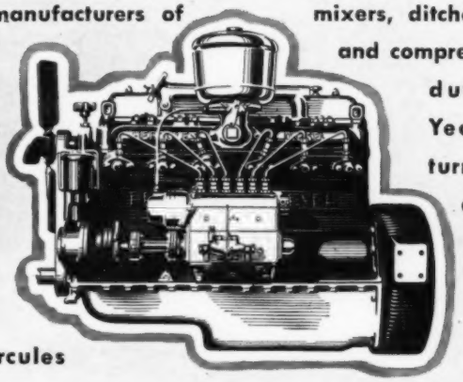

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Highway Bills Now Before Congress Provide for Major Three Year Program

Highway funds authorized in two bills pending in Congress on May first, plus present unexpended funds, provide for an uninterrupted highway program of approximately $1,500,000,000 over a three-year period. Prospects are good for early passage of the bills, according to a statement issued by the American Road Builders' Association.

One of these bills, H. R. 11418, is the Agricultural Appropriation Bill of 1936, which makes provision for Federal Aid for the fiscal year 1937 as authorized by the Hayden-Cartwright Act of 1934. The other is H. R. 11687, the Hayden-Cartwright Bill of 1936, providing for extension of Federal Aid through 1939 and increasing Federal funds for highway construction.

The long fight conducted by the American Road Builders' Association to have Federal funds made available for improvement of secondary or farm-to-market roads won recognition in the new Hayden-Cartwright Bill, with $25,000,000 authorized by the bill for this class of roads for each of the years 1938 and 1939, the Federal funds to be matched by States the same as for primary roads.

Provision also is made in the bill for continuation of the grade crossing elimination and protection program, with $50,000,000 designated for this work for each of the two years.

Enactment of the pending highway bills would stabilize the national road building program for three years, thereby enabling highway officials, engineers, contractors, and manufacturers and producers of equipment and materials to make corresponding plans.

The Hayden-Cartwright Act of 1934, making an outright appropriation for one year and authorizing regular Federal Aid through 1937, produced immediate results in reviving the highway industry. The pending legislation, if enacted, undoubtedly would maintain the confidence that has attended highway operations since the 1934 bill was passed.

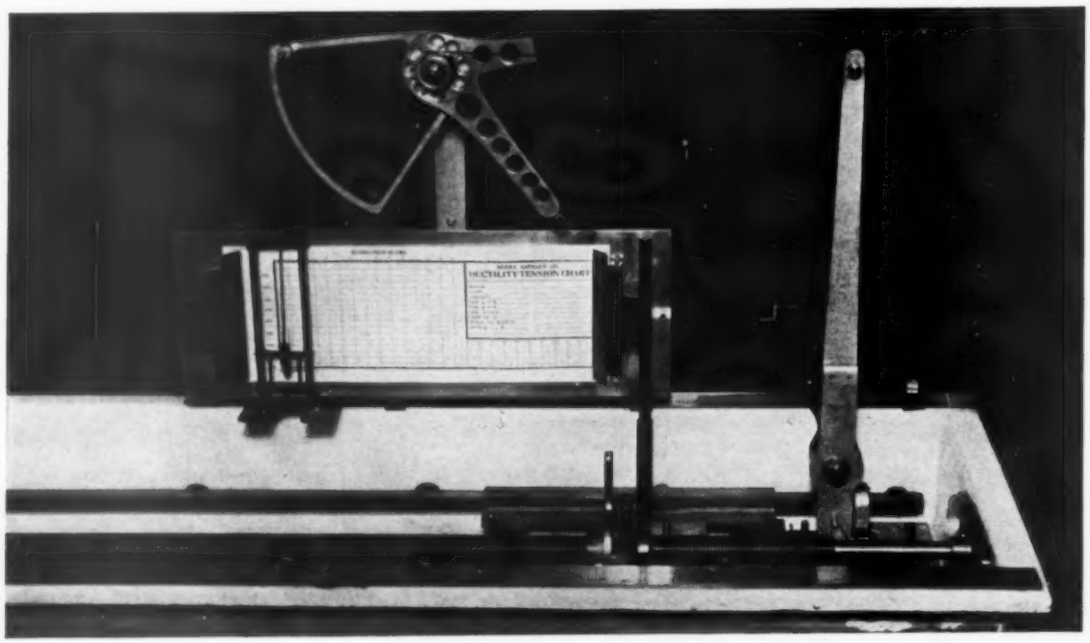
Below is a breakdown of the highway funds in prospect for the three-year period, as provided in pending bills, and remaining from previous appropriations:

$ 125,000,000	1937 Federal Aid
125,000,000	States to match
125,000,000	1938 Federal Aid
125,000,000	States to match
125,000,000	1939 Federal Aid
125,000,000	States to match
25,000,000	1938 Federal Aid for Secondary Roads
25,000,000	States to match
25,000,000	1939 Federal Aid for Secondary Roads
25,000,000	States to match
15,000,000	1938 Forest Roads (probable sum)
15,000,000	1939 Forest Roads
2,500,000	1938 Roads in non-taxable public land areas
2,500,000	1939 Roads in non-taxable public land areas
7,500,000	1938 National Parks roads
7,500,000	1939 National Parks roads
10,000,000	1938 National parkways and connections
10,000,000	1939 National parkways and connections
4,000,000	1938 Indian Reservation roads
4,000,000	1939 Indian Reservation roads
50,000,000	1938 Grade Crossings
50,000,000	1939 Grade Crossings
$1,028,000,000	
430,000,000	Funds (approximate) remaining to be expended for 1936 from Federal Aid and Works Program appropriation, including both highways and grade crossings.
$1,458,000,000	GRAND TOTAL, now available and as authorized in pending bills (but this does not include any estimate of how much the States will expend in excess of sums necessary to match Federal Aid).

New Ductile Tension Testing Machine

A new piece of apparatus for testing bituminous materials, obtaining ductility and tensile strength simultaneously and graphically drawing a chart of the results obtained was described in a paper presented by H. B. Pullar and F. R. Grant of the Berry Asphalt Co., Chicago, before the Association of Asphalt Paving Technologists at their meeting in Cleveland during the Good Road Show in January.

The machine, developed by the Asphalt company, was



Berry Ductile Tension Machine

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Made of cold drawn steel, closely spaced, American Steel and Wire Company Wire Fabric assures correct distribution of the reinforcement just as the engineer intended in his specifications. And, equally important, by choosing Wire Fabric made by the American Steel and Wire Company you can be sure there will be no "hitch" in getting materials—no risk of product imperfection—no profit taking delays in fulfilling the contract.

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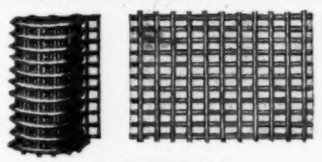

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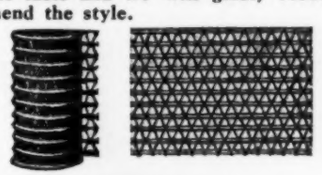

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designed to study the relative importance of ductility and tension. The asphalt specimen is hooked in place and pulled in exactly the same manner as upon the usual ductility machine.

The unusual feature, however, is the incorporation of the tensile weighing device which registers the pull by means of a self-inking pen which moves vertically as the tensile pulling machine proceeds, registering the tensile strength on the vertical lines of the graph.

The ductility is shown by the same pen as the chart moves horizontally, thus a graphical representation of the energy consumed in the elongation of the specimen is obtained, simultaneously with the ductility reading.

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Iowa Offers Graduate Courses In Highway Safety and Transportation Economics

Symposiums on highway safety, traffic control, transportation economics, and the coordination of transportation agencies will be presented as a special feature of the graduate courses in highway engineering to be offered during the 1936 Summer Quarter of Iowa State College at Ames, Iowa. The symposiums will be presented by the regular teaching staff and by a staff of visiting lecturers of prominence.

Enrollment in the graduate courses will be open to graduates of accredited colleges. The program of graduate work and the opportunities for research should be of particular interest to persons desiring to specialize in highway safety and transportation and to teachers who desire to strengthen their course work and broaden their experience in these subjects.

The 1936 Summer Quarter will provide unusual opportunities for graduate work in highway engineering. The Iowa Highway Commission, in cooperation with the Bureau of Public Roads, will have its state-wide traffic and financial survey well under way. Field inspection trips and lectures by Mr. Mark Morris of the Commission and Mr. L. E. Peabody of the Bureau, who are in charge of the surveys, will familiarize the students with this work.

Course titles are as follows:

First Term: *June* 16 *to July* 23—
Highway Safety and Traffic Control.
Transport Surveys.
Highway Pavement Slabs.

Second Term: *July* 23 *to Aug.* 29—
Cordinated Transportation Systems.
Research.

For each term of the Summer Quarter the registration fee will be as follows:

Graduate College, full time	$26.00
Fee per credit hour for less than full time	5.00
Minimum charge per term	8.00
Matriculation fee	10.00

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Twelve Governors Oppose Diversion and Federal Gasoline Taxes.—Governors of twelve states have expressed themselves recently in favor of lower gasoline taxes, in opposition to diversion of highway funds to other purposes than road building and maintenance, or against taxation of gasoline by the federal government. Seven of these public statements oppose diversion; five of them ask either for gasoline tax rate reduction or maintenance of the tax rate at a reasonable level, while three express opposition to the duplicating federal levy on motor fuel.

Roadside Planting to Reduce Maintenance Costs

During the year, nine contracts for roadside improvement were executed. These contracts covered the improvement of 41.5 miles of road and the average cost was approximately $2,400 per mile. In addition there were planted with maintenance forces a total of 13,845 roadside shade trees in 25 different counties of the State. Eight varieties of trees were used. Fifty thousand four-year old red pines were planted on sandy embankments in the Adirondack regions which were giving us trouble because of slides.

Roadside planting does much more than add to the attractiveness of the roadside. Practically all of our work, with the possible exception of the planting of shade trees, has been done with the idea of lowering future maintenance costs. For instance, the construction of U. S. Route 20 over the hills of southern Onondaga County between Cazenovia and Skaneateles involved many miles of heavy cut through earth that was more or less filled with springs and extremely unstable. The usual slope of 1 or 1½ was used. Each spring it cost the department thousands of dollars to remove the slides which had come down into the ditches and on to the shoulders and pavement. Contracts were let which provided for flattening the slopes somewhat, installing underdrains, and planting the slopes with various types of shrubbery. This planting seems to be an entire success, and it is anticipated that the probable saving in maintenance costs over the next few years will repay the cost of the planting. This type of work should be greatly extended.—*From the Annual Report of the New York State Superintendent of Public Works for the Year* 1935.

▼

New, Large Scale Maps of Transportation Routes

Sets of large-scale maps showing all details of the existing transportation system in Maine and Vermont have been prepared by the Bureau of Public Roads of the U. S. Department of Agriculture in cooperation with the U. S. Geological Survey. The maps are on a scale of 4 miles to the inch and are believed to be the best of the kind yet produced. The set for Maine consists of 6 sheets and that for Vermont of 2 sheets. Each sheet is 26 by 36 inches, so arranged as to permit binding on the left margin. The maps show in color the location and character of practically all transportation arteries such as the Federal-aid and State highway systems, important secondary highway connections, air lanes and landing fields, railroads, navigable channels and canals, thus indicating on one map all the transportation facilities in the State. The maps will supply a need long felt by commercial interests, and should be useful to State agencies and planning organizations.

The type or character of pavement on each Federal-aid or State highway as of the date of the maps is shown by appropriate symbol. The maps also show the location of all National and State parks, forests, and recreational areas in general, and the roads leading to them. The maps, however, are too large to be used conveniently for touring.

There is no supply of these maps for free distribution. Sets are obtainable only by purchase from the Superintendent of Documents, Washington, D. C., at 20 cents a sheet. Transportation maps of New Hampshire, Florida and Iowa are also available.

A LE TOURNEAU ROOTER Rips the Earth for Harrison

Laminated shale and heavy clay, overlaid in part by an old-stone-paved turnpike covered with black top—that's what confronted Harrison Construction Company at the beginning of work on Allegheny County's North Park project. Harrison put a Le Tourneau Rooter on the job, ripped up the pavement, moved load after load of rock out of the way with Le Tourneau Carryalls. Then the Rooter ripped through a layer of frozen clay and earth and went on to rip up the shale that lay underneath. As a result of this rooting, the loading time of the Carryalls was cut from 1.2 minutes to .7, and the average pay load increased from 8 to 9 pay yards.

120 Cubic Yards Per Scraper Hour

Here, on a 500-foot, one-way haul, Harrison's two Le Tourneau 12-Yard Carryalls averaged 15 loads each to move 120 yards per Scraper hour.

Harrison's experience is typical—on job after job, the country over, contractors find Le Tourneau Rooters a profitable means of speeding up work, of increasing yardage output. Ask your tractor dealer what Le Tourneau Rooters—all Le Tourneau equipment—can do for you.

Down to the Hilt in Shale—This Rooter and tractor, also used for Bulldozing, easily keep material ripped ahead of two 12-Yard Carryalls.

R. G. LE TOURNEAU, INC.

Peoria, Illinois Stockton, California

Cable Address: "Bobletorno"

Manufacturers of: ANGLEDOZERS, BUGGIES, BULLDOZERS, CARRYALL SCRAPERS, CRANES, DRAG SCRAPERS, POWER CONTROL UNITS, ROOTERS, SEMI-TRAILERS.

9 Pay Yards—Harrison consistently got loads like this in Allegheny's shale.

WE HAVE WITH US AGAIN

THE Gillette Publishing Company takes pleasure in announcing that Major Victor J. Brown, CAC-Res, has been appointed publishing director of ROADS AND STREETS. He became connected with this company in 1927 as editor in the book department. A few months later he also became an editor on ROADS AND STREETS, specializing particularly, because of his past experience as county engineer, in the highway work of counties and townships, and in design, construction and maintenance of low cost roads. In collaboration with C. N. Conner, now with the U. S. Bureau of Public Roads, he wrote the book, "Low Cost Roads and Bridges." The value of this book is indicated by the large number of copies that have been sold. After the Civilian Conservation Corps was organized, Major Brown, then a captain in the reserves, was called to active duty. After discharging a thousand men through his demobilization company at Ft. Sheridan, he was sent to a veterans' camp for a month as junior officer. From there he was transferred to command of a company at Cudahy, Wis., which was engaged in the construction of concrete jetties to prevent Lake Michigan from claiming any more of the high bluff at Sheridan Park. He did excellent work here by building a model camp for the district. The government promptly rewarded him in characteristic fashion: he was sent to Camp Skokie Valley to straighten out a company of colored gentlemen who came from East St. Louis and Chicago. Their absence from home was not very greatly lamented by the police of their respective cities. When looking out the window of his office the third day in camp he saw two negroes in a foot race—the man behind carrying a razor. He soon straightened out this company and was transferred back to the Milwaukee district, where he took over command of all camps in that area as sub-district commander. Upon his promotion to Major he was transferred to the North Woods of Wisconsin, up where the thermometer goes down to 48 and 50 degrees below zero. In making visits to his nine camps, the farthest of which were 150 miles apart, his standard equipment in the car was snowshoes, ax, shovel, dry wood and blankets. When the director of the C. C. C. ordered all officers above the grade of captain to be relieved, Major Brown returned to ROADS AND STREETS.

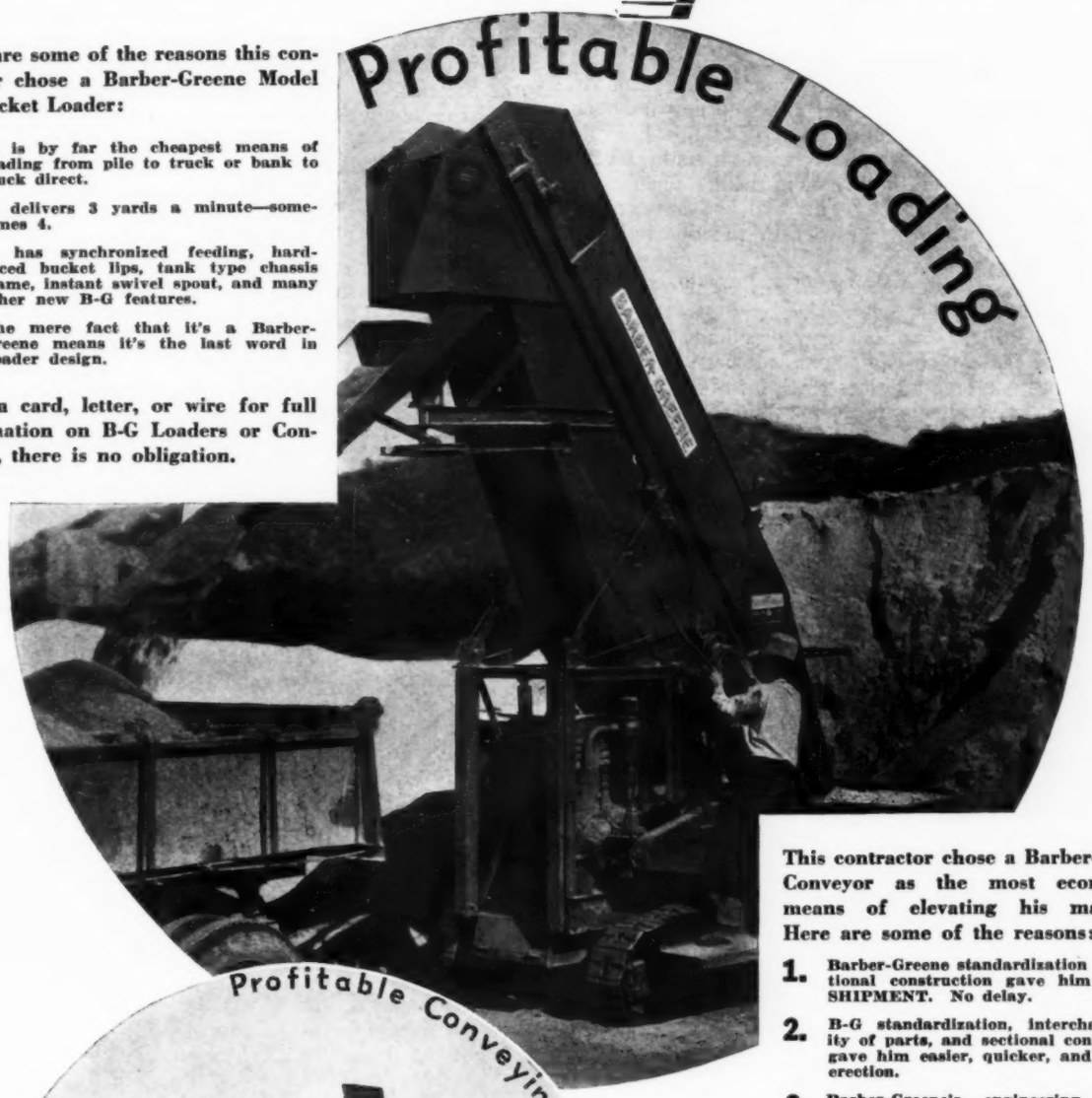
Vic Brown was born in South Omaha, Nebr. He obtained his grade schooling in Sioux City, Iowa, and entered Iowa State College at Ames in 1913. He says he had five dollars capital the night he landed. Odd jobs kept him enrolled in his civil engineering course until he couldn't make ends meet in the spring of 1914. He went to work driving a truck, saved his money and returned to Ames for the 1915 school term. When war was declared in 1917 he joined the ambulance unit being organized at Ames. No call came so he resigned and went to work as assistant county engineer in Carroll County, Iowa. In December he went to Omaha to take the examinations for pilot in the aviation service. The whirling chair test convinced him, as well as the examining officers, that he was not destined to be a flier. The world went "round and round" (like the late popular music) and he went out the door. Back he went to Carroll County to work until June, 1918, when he enlisted in the Coast Artillery Corps at Sioux City, Iowa. He spent the rest of the war at Ft. Monroe, Va. When he returned from active duty, he found, as did many of his comrades, that the greeting from employers had changed from "Good-bye and God bless you, our hero," to "Well, so *you* are back again." Jobs were scarce, so he went to Omaha, Nebr., his baggage consisting of a tooth-brush and a razor; he had $1 in his pocket. From there he went to Neligh, Nebr., as resident engineer on paving for the Rohrbaugh Engineering Co. After completing that job in 1919 he took the winter quarter of schooling at Ames and went to Rock Rapids, Iowa, for a year as assistant county engineer and resident engineer on a large street paving program. The next three years he built roads and bridges as county engineer of Clarke County, Iowa. Professor Agg, now dean of the engineering school at Iowa State, gave him outside work on tractive resistance and gasoline consumption experiments, which enabled him to graduate with B. S. in C. E. in 1925—Tthe goal he had worked toward for 12 years.

After graduation he was employed as assistant superintendent on a highway paving job for the Woodrich Construction Co. at Minneapolis. Snow began to fly, Florida was booming and he went there to fill a job as chief field engineer on a 3,000 acre development. When the Dunedin Isles project was about completed he took a job as superintendent of construction of the Gulfport, Florida, water supply system for W. E. Boyce & Co. That was completed in 1927. He moved back north and joined the Gillette Publishing Co. a few weeks later.

Vic Brown is an associate member of the American Society of Civil Engineers, a member of the Western Society of Engineers, and member of the American Road Builders Association.

Via Barber-Greenes!

Profitable Loading



Here are some of the reasons this contractor chose a Barber-Greene Model 82 Bucket Loader:

1. **It is by far the cheapest means of loading from pile to truck or bank to truck direct.**
2. **It delivers 3 yards a minute—sometimes 4.**
3. **It has synchronized feeding, hard-faced bucket lips, tank type chassis frame, instant swivel spout, and many other new B-G features.**
4. **The mere fact that it's a Barber-Greene means it's the last word in Loader design.**

Send a card, letter, or wire for full information on B-G Loaders or Conveyors, there is no obligation.

Profitable Conveying

This contractor chose a Barber-Greene Conveyor as the most economical means of elevating his materials. Here are some of the reasons:

1. **Barber-Greene standardization and sectional construction gave him STOCK SHIPMENT. No delay.**
2. **B-G standardization, interchangeability of parts, and sectional construction gave him easier, quicker, and cheaper erection.**
3. **Barber-Greene's engineering department submitted the most economical solution to his peculiar material-handling problem.**
4. **His B-G Conveyor will always be available for new jobs or changing conditions, as this conveyor can be lengthened, shortened, or otherwise altered to meet new set-ups.**
5. **Barber-Greene's ingenious design gave him the ultimate in belt conveyor economy and trouble-free operation.**

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36-20

EDITORIAL

Foundation Stones

TIME was, once, when men gathered around the country store stove to discuss events and plans of interest to them. As towns and cities sprang up over the country a printed medium was necessary to disseminate information. Roads and streets were necessary to connect these towns and the homes in them. Then came the automobile. Specialization in road and street construction and maintenance grew with the demand for better surfaces.

Because men in various parts of the country wanted to know what others in their business, industry, or profession were doing, what new facts they had uncovered, what new machinery or equipment had been developed, technical journals or magazines came into being. These magazines, like ROADS AND STREETS, promote the economic welfare of those concerned with the specialized field they serve. It is the function of this magazine to collect and disseminate information, experiences, and plans for the promotion and construction and maintenance of roads and streets. Our platform is built of policies upon which editorial articles and writings are selected for publication. This platform is the common ground upon which we meet to exchange ideas, to interpret the trend of events, to promote the economic welfare of the reader. The reader is the engineer, contractor, educator, manufacturer, and others who direct his energies toward serving the road and street field.

As commonly viewed, ROADS AND STREETS, or any technical periodical, is a commercial enterprise. But really, at its core, it is professional; its life, or reason for its existence, centers in its editorial staff. The beacons which guide the staff are the policies of the publication.

Recognizing this fundamental fact, the editor desires that those whose economic welfare is served by this magazine, understand the policies of ROADS AND STREETS. They are:

1. Planning, design and construction of highways that will be adequate as to both route and type to handle the prospective traffic safely with economy, considering not only the cost of providing and maintaining the facilities but also the cost of operation to the user.
2. Modernization of existing roads and streets in the interests of safety to meet demands of present and anticipated traffic.
3. Determination of actual and prospective traffic by means of observation and traffic analyses.
4. Financing programs for construction, maintenance, reconstruction, and administration based on the responsibilities of those benefited, viz.:
   a. The general community.
   b. Owners of land especially served.
   c. Operators of vehicles over the highways.
5. Continued opposition to the diversion, from highway purposes, of all funds collected from highway users.
6. Removal of highway work from field of politics.
7. Continuation of federal aid for state and county highways and through streets in cities and towns.
8. Appropriations for maintenance of roads and streets adequate to keep them in serviceable condition.
9. Engineering supervision and administration of road and street systems and funds.
10. Construction by contract rather than day labor or force account.
11. Employment of machinery rather than hand labor where economical.
12. Economically justifiable surfaces.
13. Planning and budgeting in counties and competent engineering supervision.
14. Elimination of township as a road administrative unit.
15. Promotion of regional planning and technical traffic regulation.
16. Recognition of highway program as a continuing investment.
17. Recognition by general public of economic significance of street and highway expenditures.
18. Advocate small toll for bridges constructed for traffic convenience where funds are insufficient to build a free bridge.

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Sabotage Calls for Action

IT HAS come to our attention that in the Toledo division on the Ohio State Highway system roadside trees planted by the highway department have been cut down recently. This sabotage has taken place where the trees stood in front of billboards.

The trees which were destroyed were planted in furtherance of the roadside beautification program conducted by State agencies, women's clubs and civic organizations. While a good road may be a smooth, hard surface, the best road is made beautiful as well as utilitarian. The planting of thousands of deciduous and evergreen trees which adorn and will eventually shade the main highways, were paid for out of funds collected from highway users.

The State department is doing a splendid job. Vandals who destroy these trees commit a serious offense against the public and should be prosecuted. Acts of this type should be nipped immediately and the "thieves of highway beautification" prosecuted. If the incident is allowed to go unnoticed it may lead to encouragement of such misdemeanors and to discouragement at further attempts toward beautification. Slap them in jail and fine them to boot.

▼

Mississippi Starts Its $42,000,000 Construction Program

THE State Highway Department of Mississippi has advertised the first letting under its $42,000,000 construction program. Bids on 92 miles alternate types pavement in 9 projects will be received on May 19. The estimate coost is $3,100,000. Similar lettings are planned for two or three week intervals until the entire program is under contract. U. S. Route 51, Memphis to Gulf Coast has 51 miles paving in first letting. U. S. Route 49 has 28 miles, U. S. Route 61, 16 miles; U. S. Route 45, 13 miles. R. A. Harris, Jackson, Miss., is chief engineer of the State Highway Department.

NOW ... IS A GOOD TIME TO

Only Highway Magazine
National Coverage Reaching
Federal, State, County
and Municipal Engineers
and Highway Contractors
Who Buy Equipment
and Materials

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$1,500,000,000

highway construction program insures great benefit to heavy industries through the purchase by contractors and federal, state and county officials of a large amount of road building machinery and materials. Approximately $47,800,000 worth of construction equipment is used for a highway construction expenditure of $100,000,000, according to a bulletin issued by U. S. Bureau of Public Roads.

ROADS and STREETS

400 W. Madison St., Chicago 155 E. 44th St., New York

NEW EQUIPMENT AND MATERIALS

A New 5-Yard Scraper

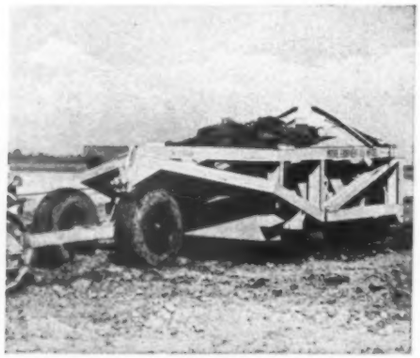
A new, low-cost, single cable scraper for use with tractors of 35 to 50 H.P. has just been announced by the Austin-Western Road Machinery Co. of Aurora, Ill.

The new scraper is not only low in first cost but the manufacturers claim an effective saving in operating costs, since the scraper pan does not dig at an angle. Instead, the front and rear of the pan are in the same plane while digging and the earth moves back freely with the forward travel of the tractor. The wheels are placed so that they travel within the 6-ft. cut of the scraper instead of on either side.

The machine performs every operation of digging, carrying and dumping through the action of a single cable mounted on a vertical winch which requires no fair-lead and is automatically locked in place when the clutch is in neutral. This simplified control permits the scraper to be coupled and ready for operation in a brief time.

The scraper cuts to a depth of 6 in. and spreads the load evenly and to any depth up to 9 in. Because the load dumps forward and spreads the material, it is stated to be possible to operate two scrapers in tandem, since the rear scraper does not climb a mound of earth left by the first.

It is claimed that plenty of digging and dumping clearance makes choking between the cutting bit and the front gate impossible, and that in spite of all possible overloading, the scraper



New Austin-Western 5-Yard Scraper

can be dumped easily while the tractor is traveling in high gear.

Because the welded H-beam frame is mounted near the pan itself it is possible to operate close to banks or on steep slopes without loss of efficiency. The frame is rigidly braced and is capable of resisting any stress that a 50-H.P. tractor can exert.

Truck type tires are used on all four wheels, permitting easy replacement at low cost, and normal wear of tractor crawls is assured, since the whole weight of the load is carried by the scraper.

▼

Compensating Device for Highway Guard Cables

Malleable Iron Fittings Co. of Branford, Connecticut, has just brought out a re-design of the compensating spring cable adjusting device which it introduced about 5 years ago.

The new design provides a spring on each cable in place of the single spring against which the two cables of the older type pulled. In the new arrangement a standard 2-in. galvanized pipe threaded into end castings provides a cover for the compensating mechanism. The device measures 23½ in. over end caps, with bolts projecting at each end—one to pass through the end anchorage post and be fastened to it—the other to provide full take-up in a wedge type cable socket. Where the unit is to be used as a sectionalizing compensating splice in the center of a run of cable, or at intervals in very long stretches of cable, both ends are provided with cable sockets. The device is completely galvanized except for the cable wedges.

The bolts are ¾-in. for test rating of 20,000 lb. without distortion, and ⅞-in. for test rating of 25,000 lb., using standard ¾-in. three-strand highway guard cable. The steel is special 80,000 lb. per sq. in. stock. The cable end sockets are similar in design for the two sizes of bolts, and provide 6 in. of take-up after the bolt has entered the threaded portion of the casting. The end anchorage bolt is designed for a 10-in. post, but longer or shorter bolts are furnished if required. The above test ratings are based on official tests in a state highway laboratory, and the construction is already approved as an acceptable standard in several states.

Guard Cable Compensator

Wrench grips are provided on the bolts to facilitate adjustment. When installed at normal temperatures, the 18-in. spring is compressed to approximately 14 in., giving a little over 1000 lb. tension on the cable. This allows nearly 2 in. further compression of the spring for contraction of the cable due to winter temperatures, when the tension will increase to 1650 lb. before the spring is fully compressed. On the other hand, when extremely high summer temperatures are encountered, the slack in the cable will be taken up by the spring opening to approximately 16 in., and still retaining about 600 lb. tension on the cable.

This maximum travel of 4 in. of the spring (the final 2 in. being required for initial stress) will take care of a 100-degree range in temperature for a maximum of about 500 ft., but the best practice requires one compensation at each end of every stretch of cable extending 300 ft. or more. On shorter stretches, one such device is adequate. One reason for requiring two compensations on stretches of more than 300 ft. is that friction of the cable in the holders on the posts may reduce compensating efficiency on greater distances.

▼

New Federal Trucks

Three new Federal heavy duty trucks have been announced by the Federal Motor Truck Co. The nominal gross rating of models 40 and 40DR is 4 to 5 tons, with total allowable weight of 20,000 lb. Model 50 has a nominal rating of 5 to 6 tons, with total allowable weight of 24,000 lb.

In designing the three new trucks, Federal engineers have, by moving the engine, radiator, cowl and cab forward, been able to gain the important advantages of shorter wheelbase and shorter overall length without decreasing the loading space and without sacrificing accessibility of the power plant and other units.

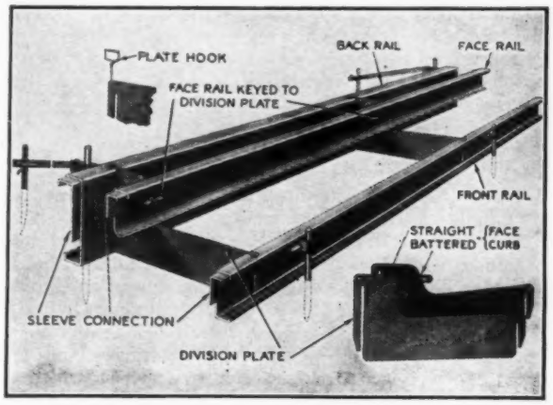
In the new 40, 40DR and 50 models, the distance from the face of the front bumper to the rear of the cab is 1½ ft. less than on former corresponding trucks, giving an 18-in. shorter wheelbase and a 16-in. shorter overall length, with the same loading space as previously furnished. This makes possible a new short wheelbase length of 135 in. Other wheelbase lengths are as follows: 145 in., 157 in., 167 in., 179 in., 192 in., 205 in. and 219 in.

The 40, 40DR and 50 models are now equipped with Timken axles, front and rear. Rear axles are the full floating bevel type on the model 40, while the models 40DR and 50 have full floating double reduction drive axles. Service brakes are Lockheed 4-wheel hydraulic, front 16-in. diameter, 2¼ in. wide, rear 17¼-in. diameter, 4 in. wide, with the exception of the model 50, in which the rear brakes are 5 in. wide. These brakes are amplified by a vacuum type booster. The 14-in. Tru-Stop single shoe disc type emergency brake is retained on the 40 and 40DR models. The 135-in. wheelbase model 50 has a 16-in. single shoe Tru-Stop brake on the transmission and longer wheelbase lengths on this model have Tru-Stop 14-in. double shoe brakes on the center cross members. Dayton cast steel wheels are now standard on models 40, 40DR and 50.

The 381 and 404 cu. in. 6-cylinder Waukesha engines used in the previous models are continued, with the improvement of downdraft carburetion, which makes a more accessible engine, and a new velocity type governor. The W. C. Lipe non-shock loading clutch with vibration dampener is now used in all three models. This 13-inch clutch operates with a cushioning action. The transmission is the latest design Clark 5-speed type with direct drive on fifth speed. Both the third and fourth speed gears are the silent helical type.

HELTZEL
Utility FORMS

Illustration below shows complete 10-ft. section of Heltzel Utility Forms for combined Curb and Gutter construction. Contractors will find Heltzel Utility Forms adaptable to all types of concrete steel work—Sidewalk, Curb, Combined Curb and Gutter and Integral Curb and Base. Write for Bulletin 200.



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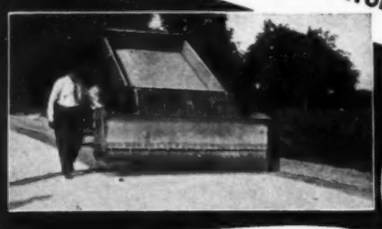
Warren, O.

FROM Missouri

"Fine for covering an emulsion seal coat because it can be handled so well when backing the truck, due to the stiff, rigid hitch."
. . . says contractor from Missouri.



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For Hot or Cold Mix Sheet Asphaltic Concrete Pavements.

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Used Cold for Penetration, Pre-Mix Road Mix (Mixed in Place) and Surface Treatment Work.

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For Cold Surface Treatment—for Hot Surface Treatment.

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A Cut-Back Asphalt for Use in Patching and Maintenance Work in Cold Weather.

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For Maintenance of Concrete Roads.

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For Brick and Granite Block Streets. For Filling Joints in Concrete Roads.

☐ CURCRETE
An Emulsified Asphalt for Curing Concrete Highways.

Mack Announces New Truck

Modern styling comes in for special emphasis on the new Model EH, just announced by Mack Trucks, Inc., New York, which rates at 18,000 lbs. gross.

Model EH is offered in standard wheelbase lengths of 146 in. and 158 in. for the truck and 139 in. for the tractor chassis, with

Mack Model EH Truck Chassis

optional lengths at extra cost. Gross weight distribution of approximately 30 per cent front and 70 per cent rear has been achieved through setback front axle design; the front axle being but 74 in. ahead of the rear of the cab.

The new model is powered by the established, 6-cylinder Model BG engine with a 3⅝ in. by 5 in. bore and stroke, which develops 79 horsepower at a governed speed of 2300 r.p.m. Among the features of this engine are case-hardened fully counterbalanced crankshaft; drop-forged, case-hardened nickel steel timing gears with generator-ground helical teeth; Mack Permafit exhaust valve seat inserts of Niferite; Mack Stabl-ite exhaust valves of austenitic steel to prevent distortion at high temperatures; offset turbulence type combustion chambers which permit high compression without detonation; radiused cylinder bores to prevent cracked cylinders between the bore and the valve deck; and cold-circulation type thermostatic temperature control to promote rapid warming of the cylinders.

Drive is from the dry, single-plate clutch through a 5-speed, unit-with-engine transmission, with direct drive in fifth as standard, an overgeared fifth being available at slight extra cost.

Rear axle is of the single-reduction, spiral-bevel type, with double reduction drive procurable at extra cost. Both are full-floating and employ Hotchkiss drive. The driveshaft has three needle-bearing universal joints with a large self-aligning center bearing. There are six optional ratios on the single reduction drive, ranging from 4.40 to 7.40; two ratios of 7.35 and 8.21 on the double reduction drive.

Four wheel brakes on the new model are of the hydraulic type and are vacuum booster actuated. Total foot brake area is 370 sq. in.

The chassis frame has a depth of 8½ in., is ¼ in. thick, and has a 3¼-in. flange. It is staunchly braced by three pressed steel, deep-flanged box girder cross members with alligator jaw attachment to the side members, and two channel cross members.

Suspension of the long, flat, easy springs is by means of Mack rubber shock insulators. Front axle is of I-beam form with reversed Elliot knuckles. Exceptional ease of steering is promoted by the Mack Archimoid steering gear having a ratio of 18 to 1.

▼

Improved Feeder—Voltage Booster

To economically improve voltage conditions on circuits where the close regulation provided by the standard station-type regulator is not necessary and where voltage control of any kind has hitherto been considered too expensive, a new type BR booster regulator is announced by Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

The Type BR booster provides a boost of 5% or 10% in one or two steps, as desired, during the heavy-load periods. The cost of the installation is very low.

The Type BR booster is particularly applicable to rural lines or distribution circuits where the load changes once or twice daily from very light to practically full load.

A voltage boost is required only during the period of heavy load, and, on such a circuit, the booster would probably operate only a few times daily.

As the supply of voltage decreases to a predetermined value; for example 94% of normal, the booster will go to the boost position and remain there until the supply voltage rises again to a certain value; for example, 96% of normal.

The standard Type BR booster is outdoor type, single-phase, with hanger irons for pole mounting.

▼

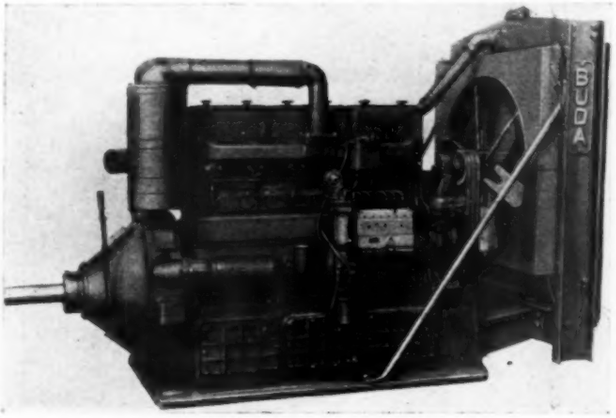
New Diesel Power Unit

The new Buda-Lanova Diesel power unit, Model 6-LD-909, announced recently by the Buda Co., Harvey, Ill., employs the use of a very unusual type of cylinder head which results in "soft combustion" and which is attained through increased turbulence and controlled combustion. This is accomplished principally through the use of an auxiliary air chamber, which, because of its function, is called the "energy cell."

In the Duda-Lanova Diesel the rate of pressure rise is stated to be well within the limits of gasoline engine practice; maximum pressures are not over 625 lb. per sq. in. The compression ratio is also comparable to that of a gasoline engine—being between 12.5 to 1 and 13.2 to 1. The unusual and controlled turbulence develops a high workable mean effective pressure.

The Buda-Lanova Model 6-LD-909, illustrated, is the most recent addition to the Buda line of industrial engines. The "909" is a 6-cylinder, 4-cycle, solid injection engine with a 5¼-in. bore and 7-in. stroke, 909 cu. in. displacement, and develops 178 H.P. at 1500 R.P.M. and 156 H.P. at 1200 R.P.M.

The crankshaft is 3½ in. in diameter, is dynamically and statically balanced, has seven steel-backed main bearings, which are of the precision type. The combined length of the main bearings



New Buda-Lanova Diesel Power Unit, Model 6-LD-909

is 18⅛ in., giving the crankshaft an unusual "riding surface." Connecting rods are 14¼ in. from center to center. Lubrication is force-feed to all main, connecting rod and camshaft bearings. Connecting rods are rifle drilled for positive lubrication.

The Buda-Lanova Model 6-DL-909 augments the 6-LD-275, 6-LD-415 and 6-LD-468, which have incorporated the Lanova "Energy Cell" combustion system for some time. Very soon the Buda Co. will announce the adaptation of the Lanova principle to all of its other large Diesels.

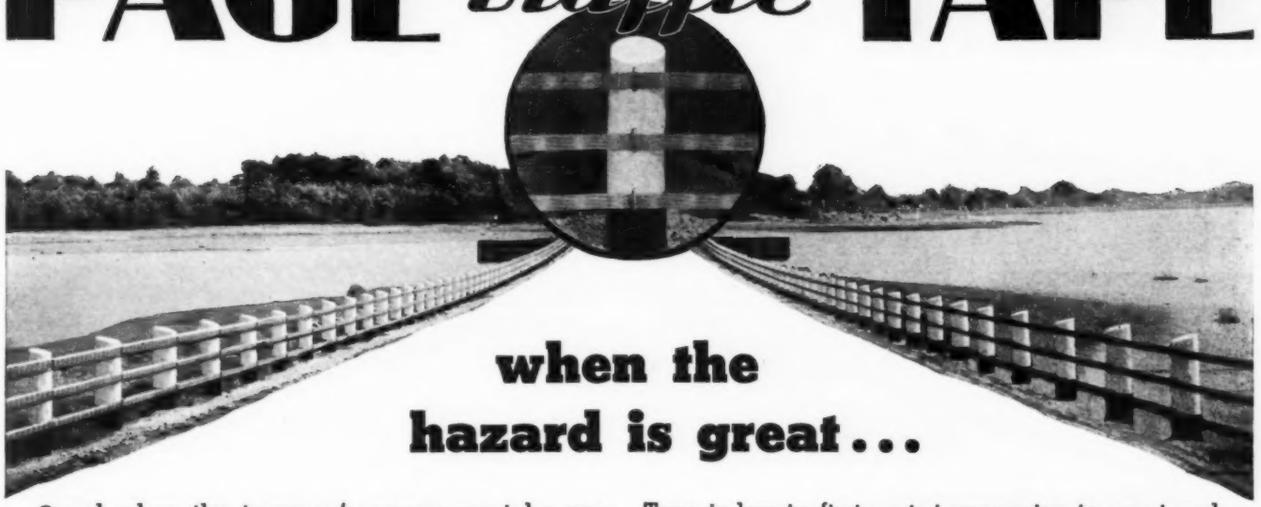
▼

New Walking Dragline Announced

The Page Engineering Co. of Chicago recently announced a new walking dragline machine built in sizes ranging from 2½ to 20 cu. yd. and known as their series "600." The series "600" machines are supplementary to other walking, crawler and truck type draglines Page has been manufacturing for a number of years.

The new series "600" Page walkers are of the two-shoe type. By means of a direct drive from the engine to the cranks attached to the side mounted shoes, movements are made, lifting and sliding the machine for a step of 6 ft. Steps are automatic at the rate of three per minute. The complete walking mechanism is based on a simple, positive crank action principle that is foolproof and offers

PAGE *traffic* TAPE



when the hazard is great...

● and when the taxpayer's money must be conserved, then you will find that Page Traffic Tape shows up to the best advantage. . . . For Page Traffic Tape *does* provide safety for the motorist. Its strong, flat, resilient bands of woven steel will give under impact, preventing excess damage to the car, yet protecting the life of the motorist. . . . Page Traffic Tape is low in first cost, inexpensive to erect and easy to maintain. . . . Its installation is easy on the taxpayer's purse, justifies the highway engineer's recommendation and assures the contractor his profit. . . . No other highway guard offers so much for so little. Sample and complete literature will be sent upon request.

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Aids Construction

TO FULFILL CONTRACTS SPEEDILY AND PROFITABLY

New developments and improvements in Blaw-Knox Construction Equipment are right in step with today's program.

With a background of years of practical experience, Blaw-Knox equipment is trustworthy. It is economical and low in maintenance. Designed to stand up under severe operating conditions, it is fitted to the job by skilled engineers. It helps immeasurably to fulfill contracts speedily and profitably.

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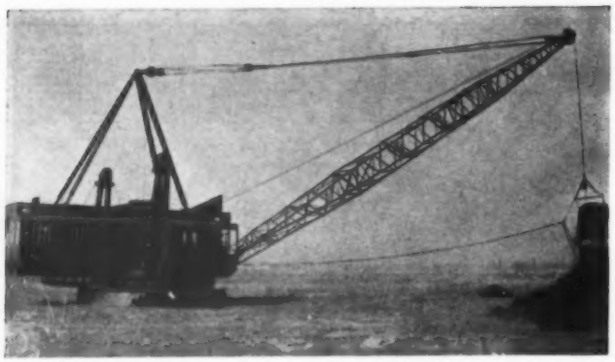


The Series "600" Type Page Walker

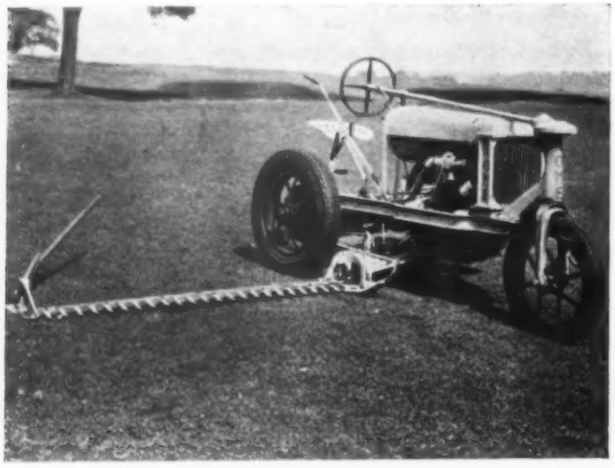
no limitations as to the size and weight machine it will handle. When the machine is digging, the shoes are held well above the ground by an automatically set brake.

Advantages claimed for the series "600" Page walker are its complete movability in any direction—the economical, medium speed, horizontal Page Diesel engine—the large base or tub thus giving ample footing for working even on the softest ground—the high fairlead which saves wear on cable—the welded alloy steel boom—the unusually high swinging hoist and load speeds—and the ability to maintain high yardage 24 hours per day, day after day, month after month.

▼

New Highway Mower

A new self-containing mowing unit, designed for mowing highway shoulders, railroad right of way, public parks, etc., has been placed on the market by the Rome Grader & Machinery Corporation, Rome, N. Y.



New Rome Highway Mower

The mower is easy to operate, small and compact, facilitating operation in corners and congested spots, among trees and other obstacles; yet its strength is ample to carry a hardy 6-ft. or 7-ft. cutter bar. The engine is a 14 H.P. rating, 4 cylinder, 3 in. bore, 4 in. stroke.

Some of the features claimed for the new mower are:

Quick acting steering gear; gears cut from special analysis steel; forgings are heat treated and hardened; shafts run on roller bearings packed in grease; engine is oiled by simple pressure system, requiring no attention; all gears, and the differential, run in oil, and are cased in for protection from dust and dirt; short wheel-base—designed for one-way corner cutting—but can be steered in either direction; solid construction of drive wheel, axle and differential side gear is simple, efficient and strong to resist shock when turning corners; operating levers are in the same location as in an automobile, greatly simplifying the problem of the beginner in operating the machine; three-point engine suspension on a three-wheel machine eliminates strains; shaft arrangement is simple; transmission is simple and compact, of automobile type design. Three speeds forward and one reverse; engine clutch is single-plate type in the fly-wheel, and is particularly simple in construction and operation; knife clutch is arranged to release and obviate damage to the knife when obstructions are encountered; knives are especially designed for high-speed cutting; starting crank, set at an angle, is exceptionally simple.

▼

A New Stopehamer Using a New Principle of Rotation

Ingersoll-Rand has recently announced a stopehamer that is stated to be faster and more powerful than any stopehamer previously built by them. The new tool makes use of an entirely different method of rotating the drill steel. The customary pawls, pawl-springs and ratchets are no longer used.

A reciprocating motion is imparted to the rifle bar by the movement of the piston, assisted by air pressure applied alternately to the faces of the rifle bar head.

When the piston moves forward the teeth of the rifle bar are actually lifted out of engagement and the bar is rotated freely. When the piston reverses the teeth are forced back into engagement in an advanced position. The returning piston is rotated by the helical flutes of the locked rifle bar, causing the steel to rotate.

The rifle bar teeth can be held out of engagement by air pressure controlled by the throttle valve. Thus hammer action without rotation is available for collaring a hole.

This pneumatic "on-off" control without extra levers or buttons is made possible by the new rotation principle.

The new stopehamer is made in two sizes, designated "SAR 120" and "SAR 85." Both are unusually light in weight and low in air consumption.

They are described in new bulletin No. 2245, copies of which may be had from Ingersoll-Rand Co., 11 Broadway, New York.

▼

H. O. Penn Machinery Co. Opens Branch at Poughkeepsie, N. Y.

The H. O. Penn Machinery Co., distributors of Construction and Industrial Equipment, 140th St. and East River, New York City, has recently opened a branch in Poughkeepsie, N. Y. In addition to its regular lines, consisting of "Caterpillar" tractors, Marion shovels, Speeder shovels, Smith mixers, Heltzel bins and forms, LeRoi compressors, Marlow pumps, Frink snow plows, etc., the Penn Co. has taken on the distribution of John Deere equipment for agricultural uses.

A complete stock of machines as well as parts, and mechanics, will be available at the Poughkeepsie location. B. W. Olin, who has been with the company for several years, is in charge, and A. W. Ketcham, who is well known in the agricultural implement business, in that section will devote his time to agricultural sales. G. Berger, formerly of the Poughkeepsie Farm Service, will be in charge of service.

Poughkeepsie, N. Y. Branch of H. O. Penn Machinery Co.

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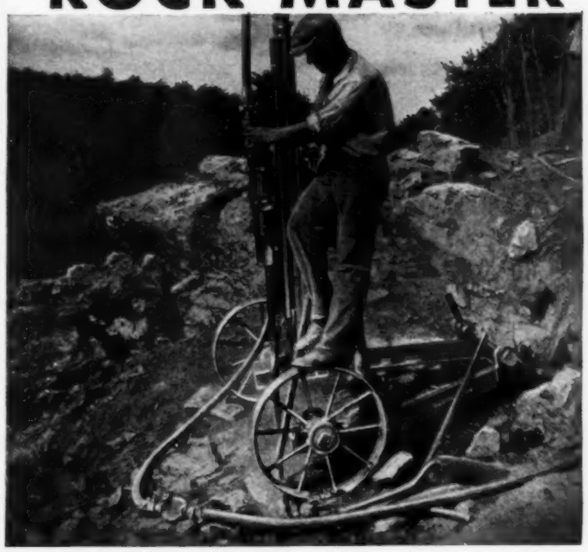
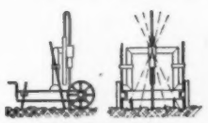
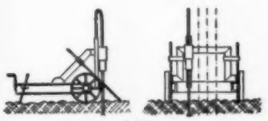
WORTHINGTON
ROCK MASTER

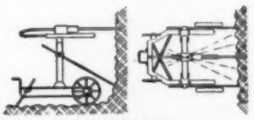


. . . the greatest advance in rock drill mounting in twenty years


Down-hole drilling

Down-hole at rear of wheel


Line drilling


Breast Drilling

Snake-holing underslung

Snake-holing above bar

A few of the Rock Master's many positions

- *Can be set anywhere, to drill in any direction*
- *Three men can move it over roughest ground*
- *Speeds up drilling . . . cuts costs*

Send for bulletin

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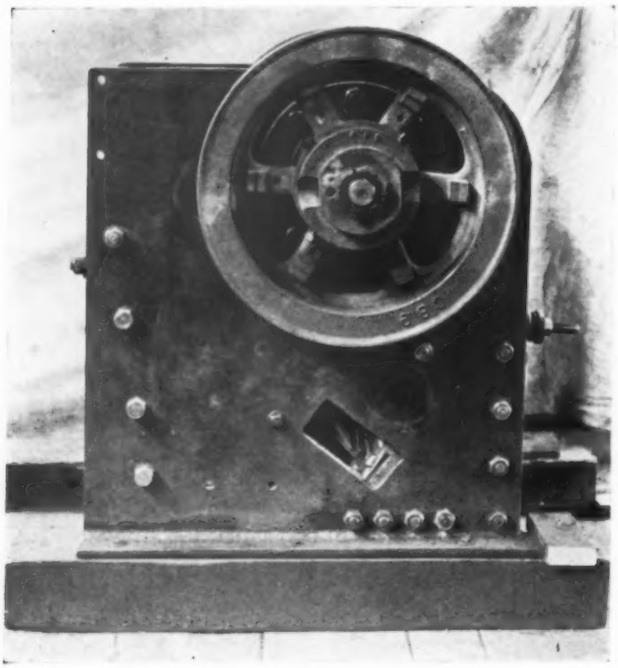
A-36234 *Offices and Representatives in Principal Cities*

WORTHINGTON

New Crusher

The Acme Road Machinery Co., Frankfort, N. Y., has begun production of a new reduction crusher. The machines are built in sizes from 2½x10 to 10x42 single eccentric roller bearings. The machine is so designed that it strikes two blows to every revolution, and is designed to run from a speed of from 400 to 600 R.P.M.



Type "C" Acme Reduction Crusher

▼

Aluminum Wheelbarrow

A wheelbarrow made of aluminum has been developed and marketed by the Sheet Aluminum Corp., Jackson, Mich. It is stated that through the use of the company's aluminum alloy in making the pan and structural type frame the total weight has been reduced to 40 lb. The wheelbarrows are equipped with pneumatic tires. Two sizes, 4½ cu. ft. and 2½ cu. ft., are being built at present. The dimensions of the 4½ cu. ft. size are as follows: Tray—Length on top, 39 in.; width on top, 24 in.; depth at front, 14 in.; depth at rear, 10 in.; extreme height, 17 in.

Wheelbarrow Made of Aluminum

WITH THE MANUFACTURERS

Petrie Tractor to Handle Link-Belt Shovels, Cranes

Petrie Tractor & Equipment Co., with offices in Billings, Butte and Great Falls, Mont., has been appointed distributors for Link-Belt crawler shovels, draglines and cranes for the state of Montana.

▼

Industrial Supplies, Memphis, Now Handles Link-Belt Line

Link-Belt Co., Chicago, Ill., announces the appointment of Industrial Supplies, Inc., Poplar Ave. and River Front, Memphis, Tenn., as authorized stock-carrying distributors of Link-Belt elevating, conveying and power transmitting chains and machinery; Caldwell screw conveyor and fittings; anti-friction bearing units; and complete silent and roller chain drives. Ample stocks are to be carried in Memphis to serve the trade with dispatch.

▼

New Distributors for Republic Steel Products

Three new distributors for Republic Steel Corporation products have been appointed, according to announcement by N. J. Clarke, vice-president in charge of sales. Equitable Equipment Co., Inc., New Orleans, La., will distribute Enduro stainless steel. The York Corrugating Co., York, Pa., has been named Toncan iron sheet distributor, as has Sheet Metal Mfg. Co., Inc., Stamford, Conn. The latter is a branch of the same firm in Brooklyn which had previously been appointed distributors of Toncan sheets.

▼

Funderburg Now Superintendent Leeds Plant Universal Atlas

Appointment of L. M. Funderburg as superintendent of the Leeds, Ala., plant of the Universal Atlas Cement Co., a subsidiary of the United States Steel Corp., is announced by B. F. Affleck, president of the company. He succeeds B. E. Merrell, whose death occurred March 4. Mr. Funderburg has been with the company over 12 years and since May, 1930, has been assistant plant superintendent at Leeds. Prior to his cement connection he was plant engineer for the Alabama By-Products Corporation. He was born in Gadsden and attended the Alabama Polytechnic Institute.

▼

Dow Chemical to Increase Stock

The stockholders of the Dow Chemical Co., Midland, Mich., at a special meeting held April 21 amended the company's articles of association by increasing the authorized amount of non par value stock from one million to two million shares and the amount of preferred stock from thirty thousand to sixty thousand shares. Holders of the company's 7 per cent cumulative preferred stock will have the privilege of exchanging it, share for share for the new 5 per cent cumulative preferred stock. The quarterly dividend at the 7 per cent annual rate will be paid Aug. 15, 1936, on all stock surrendered for exchange. Any of the 7 per cent stock which shall not have been deposited for exchange prior to June 22 will be called for redemption on Aug. 15, 1936. The board of directors took action providing for exchange of the outstanding 7 per cent cumulative preferred stock for the new 5 per cent cumulative and called for redemption on Aug. 15, 1936, all its 7 per cent preferred stock which shall not in the meantime have been so exchanged. No additional stock was offered for sale.

▼

Promotions Feature "Caterpillar" Meeting

At the annual stockholders meeting of Caterpillar Tractor Co., recently held at the offices of the Company at San Leandro, California, the entire Board of Directors was re-elected for the ensuing year. These directors, at their meeting immediately following the stockholders' session, re-elected officers of the company, with the following changes:

A. T. Brown, formerly General Auditor and Assistant Secretary of the company was elected a Vice President; D. G. Sher-

Maintain Secondary Roads at 8 to 15 miles per hour

Willett Patented Springs Absorb Road Shocks

Will It Work? It Will If It's A Willett!

Willett Spring-Scrapers on trucks are maintaining thousands of miles of roads each year at half the cost of other methods.

Write or wire for complete information.

Willett Manufacturing Corporation PLYMOUTH, INDIANA, U. S. A.

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for owners

MICHIGAN TRUCK SHOVELS earn for owners in many ways. In *time saved*, for example. The Michigan's 25 m.p.h. road speed lessens time between jobs, increases productive hours . . . Besides being a highly portable unit, the Michigan is quickly convertible to crane, clamshell, dragline, trench-hoe, backfiller or skimmer. Full-circle loading is another noteworthy advantage . . . Michigan ruggedness is worthy of much larger, costlier equipment. Model T-6 (see photo) is priced unusually LOW—with maintenance and operating costs comparable with those of an ordinary truck . . . Get full particulars NOW. Write for Bulletin "RS."

• MICHIGAN POWER SHOVEL CO. Benton Harbor, Mich.

win, Vice President, was also named Treasurer, succeeding Henry M. Hale, who has been appointed Manager of the Eastern Sales Division; E. R. Galvin, the former Eastern Sales Manager, was advanced to the post of Assistant General Sales Manager.

Since the appointment of Manuel Rogers as General Factory Manager and James R. Munro as Factory Manager of the Tractor Plant, Benjamin B. Gracier has been promoted to Factory Manager of the Road Machinery Plant. At the same time, W. E. Bergstrom was advanced to the position of Assistant General Auditor.

▼

Kircherer New Works Manager for American Hoist & Derrick

Harry J. Kircherer has been appointed works manager by the American Hoist & Derrick Co. of St. Paul, Minn. Mr. Kircherer comes from the Caterpillar Tractor Co., Peoria, Ill. He was formerly a St. Paul man, having previously been with the Russell Grader Co. before it was absorbed by Caterpillar. He was graduated as a mechanical engineer from the University of Iowa and has had 20 years of practical experience in the manufacturing of construction equipment, road machinery and other mechanical products. He is a member and past chairman of the Northwest Chapter of the American Society of Metals.

Harry J. Kircherer

▼

NEW LITERATURE

Carryall Scrapers.—R. G. LeTourneau, Inc., Peoria, Ill., and Stockton, Calif., has issued a 16-page folder describing its 12, 8 and 6 yd. carryall scrapers. Diagrams showing how the scrapers are operated are given as well as numerous on-the-job illustrations. Specifications for the three scrapers are included.

Strike Off and Mixers.—The Ransome Concrete Machinery Co., of Dunellen, N. J., have just issued two new bulletins. One covers the new Ransome mechanical strike off. The other provides complete data and specifications on the newest models of the well known 7-S and 10-S Model T Ransome Concrete Mixers.

Compressed Air Aftercoolers.—Sullivan Machinery Co., Dept. 23, Michigan City, Ind., announces a new bulletin (No. 88-W) describing the company's line of compressed air aftercoolers. Features stressed are the multipass design, the use of a built-in separator and the provisions made for quick, easy cleaning of the cooling tubes.

Power Shovel—A 24-page illustrated booklet featuring the ¾ swing Austin-Western Badger shovel has just been produced by the Austin-Western Road Machinery Co., Aurora, Ill. The booklet not only discusses and compares the features which it is claimed make this shovel an improvement, but discusses and illustrates methods of operating on all types of jobs. Copies can be obtained by addressing the Austin-Western Road Machinery Co., Aurora, Ill.

Shovels, Cranes, Draglines—A new catalog has been issued by Bay City Shovels, Inc., Bay City, Mich., containing complete specifications, working range diagrams and illustrations of the entire line of Bay City convertible shovels, cranes, draglines and trench hoes in ten sizes and models from ⅜ to 1¼ cu. yd. Bay City trailers and truck mounted machines also are included. The catalog is most attractive in appearance and typography and contains very complete specifications and data. Copies of Catalog G can be obtained on request.

Maintenance of Calcium Chloride Stabilized Roads—Since the original bulletin on maintenance of stabilized roads was issued by the Calcium Chloride Association, much additional knowledge has been gained along these lines. The association's research staff, following its purpose of providing an up-to-date source of information on stabilizing roads has just recently prepared a revised and more complete bulletin on maintenance. This new bulletin covers the various phases of stabilized road maintenance thoroughly and concisely, and is profusely illustrated, to show various operations and equipment. The new bulletin No. 18, entitled "Maintenance of Calcium Chloride Stabilized Roads," may be secured without charge by request addressed to the Calcium Chloride Association, 4145 Penobscot Building, Detroit, Mich.

Auto Patrols—"'Caterpillar' Auto Patrols, for Year 'Round Service," is the title of a new catalog issued by Caterpillar Tractor Co. of Peoria, Ill. The booklet obtains the maximum value from halftone illustrations, the principal model views of the four Auto Patrol models extending across two full pages. Almost every leaf of the 38-page catalog contains large reproductions of parts and assemblies. Action photographs depict the year-around use of the machines in road construction, finishing and maintenance, oil mix, scarifying and snow removal. The products described are the Diesel No. 11 and No. 10, and the gasoline-powered No. 11 and No. 10 Auto Patrols. All technical points of interest to the road machine user are fully discussed in an interesting and non-technical manner. Copies may be obtained from the manufacturer or any "Caterpillar" distributor.

Motor Graders.—A new motor grader bulletin entitled "Judge Motor Graders At The Blade" has just been released by the Austin-Western Road Machinery Co., Aurora, Ill. The bulletin lists the four things that the machine must do in order to perform successfully on every type of motor grader work. With these four points as the basis of the bulletin, the latest "77" Senior Dual Drive motor grader is analyzed to show how every feature of design or construction contributes to one or more of these major considerations. Attachments such as snow plows, bulldozers, scarifyers, etc., are described in additional pages at the back of the bulletin. Profusely illustrated, "Judge Motor Graders At The Blade" is intended to provide a complete description of what motor graders are capable of accomplishing as well as to supply information to customers and prospects.

Colprovia Roads.—Uses, manufacture, advantages, required quantities, and details of handling Colprovia asphaltic paving materials are outlined in an 8x10-in. pamphlet issued last month by Colprovia Roads, Inc., 183 East Main St., Rochester, N. Y. There is a profusion of pictures showing construction work and finished pavements. The following points are brought out.

Colprovia is a cold-mixed, cold-laid material which takes its set under compression when rolled. It can be mixed to conform to any recognized standard bituminous requirement, with either coarse or fine aggregate. Only such aggregates are used as are proved suitable by laboratory tests.

Accurate laying—either mechanically or by hand—is easily obtained because of the controlled setting. Traffic is allowed on the pavement immediately after rolling. Mixes are designed for the entire range of surfaces from heavy duty streets to secondary roads.

Patching and the evening-up of old pavements are among the important uses of this product. It is also used as a seal coat.

Stabilized Road Specifications—Revisions according to the latest findings in service behavior of stabilized roads have been incorporated in a new and revised edition of "Typical Specifications for Low Cost Wearing Courses for Roads Stabilized with Calcium Chloride and Binder Soil," Bulletin No. 20 of the Calcium Chloride Association. The revisions were determined by the association's technical committee, made up of its staff engineers and the stabilization engineers for the member-producers, at a meeting in Detroit on March 26-27. The most significant change is the reduction of the proportion of soil fines. The specification for gradation, as now revised, makes accurate allowance for just sufficient of the binder soil to fill the voids in the frictional material. It is believed that construction conforming to the revised gradations will practically insure maximum wet and dry weather stability. The new specifications devote a section to plant mixing. An appendix is also included on stabilization of sand-clay mixtures, as especially adapted to road construction in sandy areas and for low cost surfacing of playgrounds, tennis courts, etc. The bulletin (No. 20) is now available without charge upon request. Write to any of the member-producers or to the Calcium Chloride Association offices at 4145 Penobscot Building, Detroit, Mich.